The Engineer

LONDON, FRIDAY, OCTOBER 9, 1942.

PUBLIC NOTICES

LINDSEY COUNTY COUNCIL EDUCATION COMMITTEE

COUNTY TECHNICAL COLLEGE, GAINSBOROUGH

A Teacher is Required for Day and Evening ENGINEERING CLASSES up to Higher National Certificate standard. Candidates should possess a Degree in Engineering and have had Industrial Experience. Burnham Technical Scale.

Particulars and forms of application may be obtained from the Principal, to whom applications should be returned as soon as possible.

F. J. BIRKBECK,
Director of Education.

Education Department,
County Offices,
Lincoln,
24th September, 1942. 8837

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

TO ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge, and co-operation is asked for.

IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

STATUTORY RULES & ORDERS 1941 No. 2069

RESTRICTION ON ENGAGEMENT ORDER

CHIEF MAINTENANCE ENGINEER, to Control all Repairs, Mechanical and Electrical, and Maintenance and Installation of Plant.—Address, 8812, The Engineer Office. 8812 A

ENGINEER REQUIRED for Permanent Post on work of first national importance; age 30 to 42. First-class general and technical education essential, with good executive experience and knowledge of modern manufacturing methods. Salary £1000 per annum, rising to £1800 per annum.—Full details, including technical qualifications, positions held, and salaries earned, in confidence, to Box 11, Strand House, London, W.C.2. 8846 A

FOUNDRY MANAGER.—WANTED for Works in London area, MANAGER for large Iron-foundry producing variety of Castings from a few lb. to several tons. Applicants must have held position as Manager or Assistant Manager in reputable found.y, and be fully conversant with Modern Foundry Practice.—Write, stating fully previous experience, age, salary required, Box 937, Sells, Ltd., Brettenham House, Strand, W.C.2. 8839 A

MANAGING DIRECTOR.—The Directors of WILLFORD and CO., Ltd., Spring Manufacturers, of Sheffield, DESIRE to FILL the VACANCY caused by the death of their MANAGING DIRECTOR.—Applications, which will be treated in the strictest confidence, should be addressed to the CHAIRMAN, Captain Allan Kyle, Croxton Park, near Grantham. 8843 A

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Address, 8847, The Engineer Office. 8847 A

OWNER/MANAGER, General Engineering Works, REQUIRES ASSISTANT to deal with technical correspondence; over military age; country district.—Address, 8844, The Engineer Office. 8844 A

THE Post You are Seeking May Not be Advertised in this Column, but do not lose the Opportunity of Bringing your Requirements before all those who would be interested and could employ you. An Advertisement in the "Situations Wanted" Column would be seen by all Leading Engineering Concerns for the cost of Four Lines, 6s.; 1s. 6d. for each Additional Line. There is no better way of covering so large a field for such a small charge.

The Engineer

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CORRESPONDENCE *re* Accounts and Remittances should be sent in future to:

28, ESSEX STREET, STRAND, LONDON, W.C.2, and NOT to Bath.

This change has been caused by enemy action, and co-operation is earnestly asked for.

SITUATIONS OPEN

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SITUATIONS OPEN

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OVERSEAS EMPLOYMENT.—A LECTURER in ENGINEERING is REQUIRED for the Achimota College, Gold Coast, for two years, with possible permanency. Salary, £475 a year, rising to £840. Separation allowance for married men is £80 on salary of £475. A higher commencing salary may be offered to an exceptionally well-qualified candidate. Free passages and quarters. Candidates should possess an Honours Degree in Engineering, be Associate Members of the Institution of Civil, Mechanical, or Electrical Engineers, and have some knowledge of Applied Electricity. Duties include Lecturing and Supervising Experiments in Applied Thermodynamics and Theory of Machines as main subjects for London External B.Sc. Engineering Degree Courses.—Written applications (no interviews), giving full particulars of age, qualifications, experience, and name of present employers, should be sent to the SECRETARY, Overseas Manpower Committee (Ref. 391), Ministry of Labour and National Service, Hanway House, Red Lion Square, London, W.C.1. 8834 A

STOREKEEPER-MANAGER.—An Important Firm of Heavy Engineers in Lancashire, employed on Government contracts, are anxious to PLACE the RECEIVING, CUSTODY, and ACCOUNTING of STORES in their Workshops under competent MANAGEMENT. Applicants must be active and energetic, have had previous experience of a similar nature in Engineering Works, and well qualified to Take Charge.—Write, stating age, full details of experience, and salary required, to Box No. 6936, c.o. Browns, 37, Tothill Street, S.W.1. P4414 A

SITUATIONS WANTED

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COMMERCIAL MANAGER REQUIRES CHANGE (47), wide experience buying, material control, traffic, accountancy.—Address, P4413, The Engineer Office. P4413 B

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CLASSIFIED ADVERTISEMENTS CLOSE FOR

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Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher; all other letters are to be addressed to the Editor of THE ENGINEER.

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PATENTS

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THE PROPRIETORS of BRITISH PATENT, No. 448,691, for "Mechanism for Filling a Bag-like Receptacle with a Substance such as Tea or Coffee," are DESIROUS of ENTERING into ARRANGEMENTS with British Manufacturers by way of LICENCE or otherwise, so as to SECURE the FULL COMMERCIAL DEVELOPMENT of the INVENTION.—Address all communications in the first instance to GEORGE T. FUERY, Newhall Chambers, 8, Newhall Street, Birmingham, 3. P4420 H

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For continuation of Small Advertisements see page 60.

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A Seven-Day Journal

British War Production

SPEAKING in New York on Saturday, October 3rd, to the Foreign Policy Association, Lord Halifax, the British Ambassador to the United States, stated that British war production per head of the population was greater than any nation on the earth. Britain, he said, with a population of 47 millions was producing as many aircraft as Germany was with its population of 80 millions. In the eighteen months which ended in July last we multiplied our output of tanks by three. In the matter of shipbuilding and ship-repairing, we have built and repaired 30 per cent. more shipping than in the corresponding period of the last war, although we have in our shipyards 100,000 fewer shipyard workers. Our achievement was not merely only of quantity, for we had challenged and outmatched the inventive genius of German chemists and engineers. There was no doubt that in aircraft design Britain held her own. In radiolocation, by which the anti-aircraft guns and the night fighters were enabled to find their targets, Britain was easily first in the field. When Hitler produced his "secret weapon," the magnetic mine, the antidote was discovered in a few days and applied in a few weeks. Some most astonishing simplifications in industrial processes had been introduced. Thus the 2½ man-hours which were formerly needed in order to produce one machine gun component had been reduced to 6 min. The "Lancaster" bomber, Lord Halifax went on to say, was now being built in one-third the time which was originally required for building machines of that size. Speaking of the British *morale* which carried the nation through 1940, Lord Halifax recalled how we watched on the map the passage of precious shiploads of rifles across the Atlantic. They were, he said, torn out of the holds of the ships and rushed to waiting, empty-handed soldiers. Productive power, communications, and *morale* were the raw materials of victory, and the greatest of these was *morale*. On the Battle of the Atlantic, Lord Halifax said that America and Great Britain were still holding the seas against unremitting attacks. We could not be content until we were able to deal with the U-boats faster than Germany could build them.

Night Photographs Over Germany

THE Air Ministry has recently issued particulars of the method which is now employed to photograph bombing targets in Germany, taking the photographs at the exact time that the bomb is falling. This is done by employing a photographic flash bomb of 50 million candlepower, which on exploding emits a blinding white light lasting about one-tenth of a second. As an aircraft reaches its target and releases its bombs, a photo-flash bomb is automatically dropped, and a camera with the shutter already open takes a photograph of the area already lit up by the flash. In former practice, perhaps as many as ten or eleven operations were necessary to take a successful photograph of the area bombed, and in the few crucial moments over the target area, very often difficulties would occur which might prevent successful photographs being taken. Under the new system all that is needed is for the pilot to hold the aircraft level for a few seconds when he has been warned by an automatic light that the photo-flash bomb is about to explode. As soon as aircraft returning from a raid reach their dispersal point, the camera magazines are fetched and are developed in total darkness. The films, which are very sensitive, are developed, fixed, rinsed, and dried in a very short time, not a second being wasted. The finished prints then pass to the intelligence section of the station, and go on to the group headquarters and Bomber Command. By this means navigation is helped and anything new in German camouflage or decoy is discovered. The fires caused are shown very clearly in the photographs taken, and since each photograph is timed, a clear idea of the progress of the fires and their number is readily obtained. Considerable interest, it is stated, is being taken by the bomber crews in the new method of photography. Throughout the Command there has been started a squadron ladder, on which points for photographs which show either the target area or an area close to it are allotted. It is the desire of every squadron to be at the top of the ladder, for in that position the squadron which has done the best for a month throughout the whole Command is made known. One group was recently able to boast that for the month of July it held the first seven places on the squadron ladder.

The Retirement of Sir Julian Foley

IT is announced that Sir Julian Foley, C.B., will retire from the post of Deputy Director-General (Shipping—Group 1) in the Ministry of War Transport at the end of October. Sir Julian, we may recall, was appointed to the Ministry in May, 1931, when the amalgamation of the two Ministries of Shipping and Transport took place. He was born in Liverpool in 1881, and received his education at Liverpool College and the Universities of London and Liverpool, and entered the Transport Department of the Admiralty in 1907. In the last war Sir Julian was made Assistant Director of Transport in 1915, and later was appointed Director of Military Sea Transport in the Ministry of Shipping, in which he served from 1917 until the end of the war. From 1920 until 1927 he was Under-Secretary in the Department of Mines, and was then appointed Director of Sea Transport under the Board of Trade. In 1929 Sir Julian became Assistant Secretary in charge of the Mercantile Marine Department, and on the retirement of Sir Charles Hipwood in 1932 succeeded him as head of the Department and Under-Secretary of the Board of Trade. In 1939, when the Ministry of Shipping was formed, Sir Julian was transferred to it as Secretary. During more than thirty years, in which he has been in contact with the Admiralty and the Board of Trade on matters concerning ships and shipping, Sir Julian has rendered signal service to his country. He had much to do with the Government schemes before the war for the rehabilitation of tramp shipping and the replacement of tonnage under the "Scrap and Build" scheme. He was made a Companion of the Bath in 1919 and a Knight in the Jubilee Honours List of 1936. From 1938 to 1939 he served as President of the Institute of Marine Engineers. He has received honours not only from his own country, but also from France, Belgium, and Russia, and many of our readers to whom he is known will join us in wishing him many years of happy retirement.

Wage Increases

SPEAKING on wages and inflation, in the House of Lords on Wednesday, September 30th, Lord Gainford, after giving some examples of increased wages, said: "There was no suggestion that these higher wages were to result in increased war production. Increases were being asked for merely because they had been received by others. The women employed in engineering works were asking for 85 to 100 per cent. of what the men were going to get. The men employed in the iron and steel industry were asking for an increase in their wages. His own firm, continued Lord Gainford, received on Friday last applications from four different sets of workers employed by the firm. The first was from workers in the iron and steel trade, who claimed an increase in the melters' sliding scale from 62½ to 80 per cent., and an increase of 12½ per cent., or 10d. per shift, in the base rates. They attached to their demand a memorandum which included a summary of the wartime increases in other important industries, such as engineering, shipbuilding, coal-mining, building, civil engineering, and so on. He never saw a franker avowal of the reason for asking for a wage increase, namely, because others had received it. Because others had received it, they claimed that they deserved it, although they were not necessarily going to produce anything more in return. His firm got an application from the National Guild of Municipal Workers, who asked for a new sliding scale. All the men employed at the company's blast-furnaces had asked for an increased overtime rate, while the North-East Coast bricklayers' labourers had also asked for a further increase. These increases went on from day to day. One could pick up the newspaper and almost every day read of new applications for increases in wages—always put forward on the same ground that somebody else had got an advance."

A Scottish Tank Recognition Tour

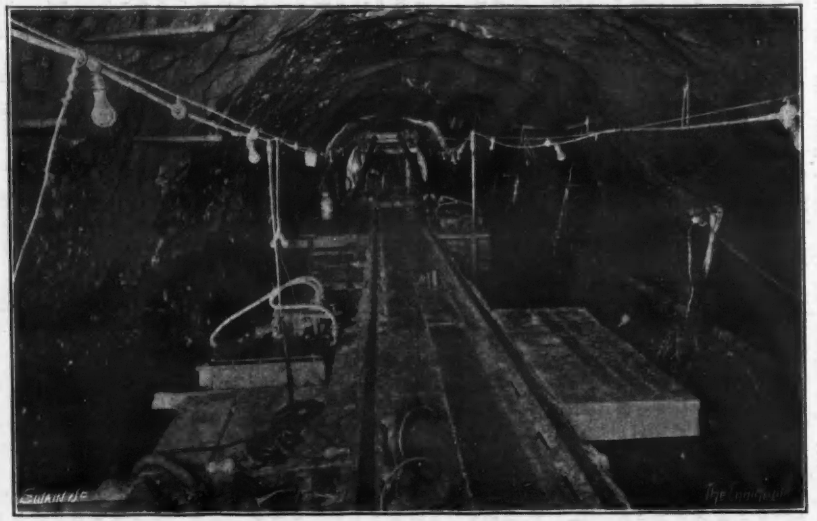
WITH a view to familiarising our Home Forces with the appearance and characteristics of British and foreign armoured fighting vehicles, it has been arranged for a "circus" of British, German, and Italian tanks to tour the different military camps in Scotland for the purpose of improving tank recognition. Among the tanks included in this international collection are the "Churchill," "Matilda," and "Valentine," representing British tanks; an "MII/39," Italian tank; and "PZW 1," "PZW 3," and "PZW 4" German tanks. In addressing his audience at one camp it was explained by the tank officer that the task of recognising British and enemy tanks was both difficult and complex. In many cases tanks did not differ materially from each other in size and construction, and in actual warfare, particularly in unfavourable weather, one tank, when viewed from a distance, looks very much the same as another. The constructional features of the German and Italian exhibits were explained, and outstanding points were mentioned with regard to the design and construction of leading British tanks, such as the "Valentine," "Crusader," "Covenanter," and "Churchill," the contrast between the British and the Axis tanks being explained.

Mobilisation of Britain's Industrial Man Power

IN an address delivered in Birmingham on Monday, October 5th, to the Birmingham Rotary Club, Mr. M. S. McCorquodale, the Parliamentary Secretary of the Ministry of Labour and National Service, sketched the background from which the Essential Work Orders and other Government labour controls had emerged. He said that in September, 1942, the number of people who were covered by the Orders, excluding the merchant navy and the dock Orders, was not far short of 7,500,000. In the month of August the applications from workers for permission to move were only 1·7 per cent. of the number employed in scheduled undertakings, while employers sought to discharge only 0·6 per cent. The great majority of the applications in each case were granted. With regard to complaints which had been made that the Orders were prejudicial to discipline, he believed that where good personal management and good works committees existed, factory discipline was all right in general. Referring to the procedure for dealing with absenteeism and persistent lateness under the various Orders, which made these actions offences for which prosecution could take place, Mr. McCorquodale want on to describe the precautions which were taken against unfair treatment. During August, he said, there had been 245 prosecutions, with penalties ranging from two to three months' imprisonment, Fines from £2 to £60 were imposed. Orders were constantly under review. They were not perfect, but they had achieved a considerable amount of success without incurring the hostility of either employers or workers. In conclusion, Mr. McCorquodale said that while Germany needed the Gestapo and the most ruthless system of force to mobilise her forces, through our free institutions by goodwill and by agreement we had accomplished a mobilisation and control of our man power and woman power most certainly not less complete.

CONSTRUCTION OF THE DELAWARE AQUEDUCT

(*For description see opposite page*)



CLEARING MUCK FROM TUNNEL INVERT
POURING CONCRETE FOR THE INVERT

MOVABLE PLATFORM TO CARRY CONCRETE AGITATOR CARS
CONCRETING OF INVERT COMPLETED

Delaware Aqueduct

No. VI—(*Continued from page 272, October 2nd*)

Placing Tunnel Lining

THE work of placing the concrete lining of the tunnel has been under way for the better part of a year, and the work is thoroughly systematised and is carried on from each of the three shafts in substantially the same way. The practice is first to place the concrete for the invert, and then to place the arch which constitutes the remainder of a section of lining. The concrete is mixed at a surface plant at each shaft. Each concrete plant is composed of an elevated automatic batching plant that is fed the required aggregate and cement from overhead bins, and the batched materials are dropped to the mixers directly below at the ground level, three in number. Each mixer handles the batch for one minute, and the three mixers operate successively. A batch can be produced every 30 sec. if so scheduled. The 1-yard mix, from each of these units, is dropped down a shaft through a 12in. pipe that delivers the concrete to a hopper at the bottom of the shaft from which the material

COLLAPSIBLE METAL FORMS FOR CONCRETING ARCH

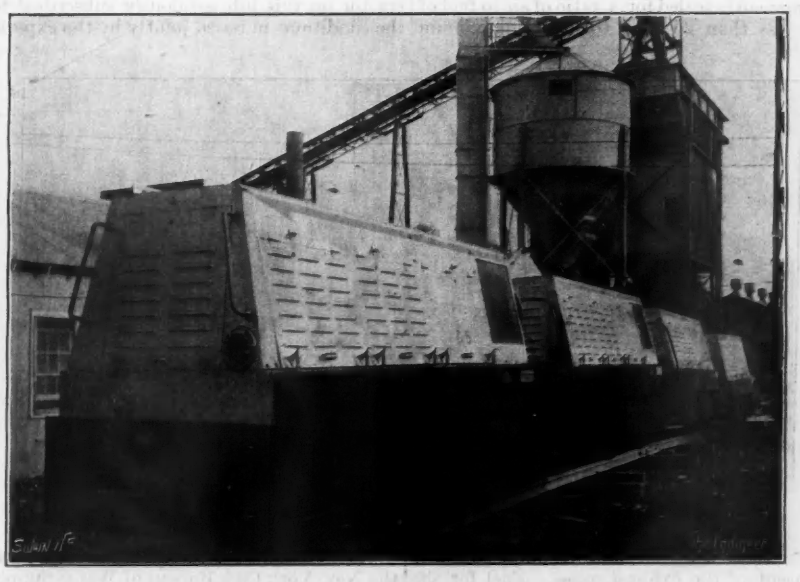
can be fed by gravity into Blaw-Knox 5-yard agitator cars spotted conveniently for that purpose. A train is made up of four of these cars, and all can be loaded within a span of 10 min. Samuel R. Rosoff, Ltd., is responsible for another innovation, inasmuch as the company uses oil engines for hauling the concrete trains, whereas all other contractors have been employing storage battery locomotives. The reasons for this change will be explained after we have described other phases of the lining work.

Lining operations are carried out in four stages, as follows:—(1) The concrete kerbs are poured on the two sides of the invert, and when the concrete has set the main line 36in. track is removed and shifted to form a wide-gauge track supported by the kerbs; (2) the muck in the invert between the kerbs is then removed by a bulldozer and a drag-line excavator; (3) the concrete of the invert is poured after that clean-up. A mobile bridge, which travels on the wide-gauge track, and which may be from 700ft. to 1100ft. long, carries, itself, a main track of 3ft. gauge, and a switch long enough to allow concrete trains to pass one another when moving to and from the shaft. Below the bridge, and also supported by the kerbs, is a track on which is drawn the screed, or strickle, that forms the concrete of the invert section, the screed being pulled by a pneumatic hoist, of 8000 lb. cable-draught capacity, using a single line. The same hoist, using a two-part line, can shift the bridge, which may weigh as much as 15,000 lb. or more when carrying forms. The concrete is dumped through the platform into the invert by the agitator cars and, after screeding, the concrete is smoothed by hand. (4) Blaw-Knox collapsible forms are used for the lining arch, and concrete is delivered behind the forms by two Pressweld pneumatic placers, each of 1-yard capacity, operated with air at a pressure of from 90 lb. to 100 lb. per square inch. The invert has been placed at an average rate of 550ft. in an eight-hour shift, and the arch has been placed at an average rate of 385 linear feet a day. Just before a car dumps into the invert or into the Pressweld pneumatic placers, the agitator of a car revolves for the purpose of discharging the concrete. Power for this purpose is obtained from the power line running along one side of the tunnel.

It may be imagined by many people handling such material that the dropping of concrete through a vertical shaft the depth of any of these shafts, and particularly Shaft 2A, 1550ft. deep, might impair the mix. Such has not been found to be the case, and the principal problem has been that of impact when reaching the bottom of the shaft. The contractor has dealt with this by providing a surge chamber, consisting of a 20in. pipe which has been reinforced externally with bands and steel rails. Contrary to expectation, but little, if any, segregation occurred at the bottom, and virtually no change in the strength of the concrete was observable between test cylinders made of a given batch at the top and after reaching the bottom of the shaft; in fact, the concrete at the shaft bottom showed some increase in strength, and the gain has been attributed to the evaporation of some of the water content. Further, the concrete showed that its strength increased rapidly during the 10 min. following discharge from a mixer, and then for the next two hours made but little gain in strength. Experiments made by the contractor also disclosed that any uncombined water in a mix would impair the strength of the concrete, but, on the other hand, if means were given for the water to effect a complete chemical combination with the cement, then the concrete would become definitely stronger. The implication is that it is unwise to stint indiscriminately the water-cement ratio.

Diesel Locomotives Underground

The contract calls for the placing of 400,000 cubic yards or 800,000 tons of concrete in the tunnel lining. All that concrete, mixed at the three shaft collars, has to be moved a maximum distance of 5 miles in the tunnel, and the time allotted for that part of the work in the contract requires speed. The question confronting the contractor was what type of locomotive would best answer for that service. During rock excavation work from the six headings, Samuel R. Rosoff, Ltd., employed storage battery locomotives of 90 H.P., with train loads of 64 tons, and capable of a maximum speed of 8 miles an hour, the longest haul being 3 miles. The maximum muck hoisted at any shaft from two headings, when driving 104ft. of tunnel in twenty-four hours, was 1000 cubic yards, equivalent approximately to 2000 tons of rock in place. Storage battery locomotives could meet that demand.

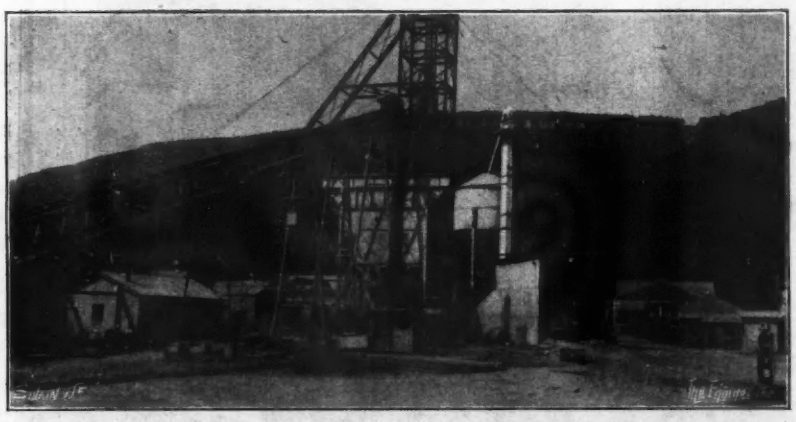


DIESEL LOCOMOTIVES FOR USE IN TUNNEL

On the other hand, the concrete plant at each shaft has a maximum capacity of 130 cubic yards per hour, corresponding to about 3000 cubic yards in twenty-four hours, and the concrete-placing equipment underground at a shaft can handle 2000 cubic yards, or 4000 tons of concrete in three eight-hour shifts. With longer hauls than 3 miles and a greater top speed than 8 miles an hour storage batteries could not have met the demands imposed by tunnel-lining operations. Trolley locomotives, which can make greater speed and are more efficient than storage battery locomotives, would not answer under the conditions prevailing. The possibility of the escape of methane gas into the tunnel at some time made a sparking trolley prohibitively dangerous. The transmission equipment for trolley locomotives would hamper the free movement of lining-placing apparatus, and trolley locomotives are considerably more expensive than the storage battery units. After careful analysis,

the experts of Samuel R. Rosoff, Ltd., decided that oil locomotives were the logical answer to the problem, provided their use underground would be permitted by the New York State Department of Labour, which had previously prohibited oil locomotives for such service. The exceptional and entirely effective system of ventilation installed to minimise the explosive hazard of occasional inflows of methane gas, which the contractor had provided, made the Department of Labour willing to grant permission to use oil locomotives in the tunnel. With this permission was a requirement that special precautions should be taken to render each locomotive peculiarly fitted for underground operation. The nature of those requirements was established by the Department of Labour after extensive investigation.

As embodied in the 160 H.P. oil locomotives of 18 m.p.h. speed, used by Samuel R. Rosoff, Ltd., we have the following facts furnished by the contractor's chief engineer: —"The flameproof, exhaust-scrubbing, and safety features of this mine type locomotive consist of the following: The main fuel injection pump of the diesel engine is set and permanently sealed for a ratio of air to fuel of not less than 20 to 1 to assure maximum



SURFACE PLANT AT SHAFT 3

combustion of fuel and a minimum CO content of the exhaust gases. Fuel for the injection pump is supplied by a fuel transfer pump on the engine and taken from a supply tank placed between frames at the front end of the locomotive. The fuel system has proper filters and the fuel tank has a 'Protectoseal' fuel filler cap, and the fuel line has a safety shut-off valve that can be tripped from the operator's station in an emergency. Air for the engine intake passes through a double unit oil bath type air filter that is mounted on the manifold labyrinth, which, in turn, connects directly with the air intake manifold of the engine. The purpose of the labyrinth is to arrest flames induced by any back-firing of the engine, and this feature is made up of a heavy cast flameproof chamber that is equipped with clean-out and inspection covers. In the chamber are mounted thin brass discs spaced to form a labyrinth which will smother any back-fire flames before they can reach the atmosphere. This unit can be readily removed for cleaning. The engine exhaust is carried from the engine through a water-cooled manifold and onward to scrubbing and cooling tanks by way of heavy steel piping, and still through steel piping the exhaust travels through the labyrinth and onward to a fan chamber, where it is mixed with air drawn through the radiators of the engine cooling system. The diluted exhaust is finally discharged to the atmosphere through a rectangular opening in one side of the locomotive hood at a point opposite the operator's position. The foregoing apparatus serves to quench any possible sparks or flames, and cools, dilutes, and cleans to the required degree the engine exhaust. The sulphur content of the engine fuel is required to be not more than 0·5 per cent.; the temperature of the exhaust gas at the point of discharge from the engine must not exceed 160 deg. Fah., and those gases are required to be diluted with at least ten times their volume of air before being released into the underground atmosphere. The contractor has been obliged, before placing a diesel locomotive in service, to provide primary exhaust ventilation underground at the rate of 10,000 cubic feet a minute or more per engine and a minimum air velocity of 30 linear feet a minute in a tunnel section, with the end of the vent pipe intake not more than 150ft. from the face nor less than 25ft. beyond the car changer. The ample ventilation available considerably exceeded the foregoing requirements."

At every step in the adoption of oil locomotives for underground work the contractor on this job sedulously subscribed to the conditions imposed jointly by the experts of the New York State Department of Labour, the New York City Bureau of Water Supply, and the U.S. Bureau of Mines. The use of electric locomotives would have required for the concreting work an estimated period of 350 days at a per diem cost of 369·84 dollars for labour, and the oil locomotives are counted upon to do the work in 300 days at a per diem labour cost of 309·10 dollars. The saving in labour and insurance alone by the use of these locomotives in hauling 400,000 cubic yards of concrete is put at 36,714 dollars. According to Mr. Fred W. Stiefel, the actual operating costs for five locomotives for a period of one month is:—

	Dollars.
Labour cost	7609·00
Insurance at 15 per cent.	1141·35
Fuel and lubrication	429·00
Repairs	600·00
Total cost per month	9779·35

The total mileage covered was 11,017 miles. Since each train hauled 20 cubic yards of concrete, or a total of 40 tons, the cost for the month was 0·0222 dollar per ton-mile, covering all expenses.

From 3000 to 3400 tons of concrete have been placed in arch lining in twenty-four hours, with a 5-mile haul. During mucking operations, a single locomotive hauled a train of twenty muck cars, each of 6 cubic yard capacity, and each car had a gross load of 11·6 tons. The total train load moved, including the weight of the locomotive, was 245 tons on a level track. There is no denying that the oil locomotive calls for more careful operation and maintenance than the usual storage battery or trolley locomotive when at work underground, and to get the maximum speed out of it entails heavier rails in the tracks and due regard to the proper placing of ties and the provision of well-constructed joints. Of course, copious ventilation is indispensable. The gains in service warrant the outlays just mentioned.

Sand and Gravel Plant

Providing aggregates for 400,000 cubic yards of concrete for the lining of 75,157 linear feet of tunnel presented a major question of supply to Samuel R. Rosoff, Ltd. Happily, the work of a prehistoric Ice Age in the Catskill Mountains left a vast deposit of glacial till in the vicinity of Shaft 2, and it was only necessary for the contractor to install there a plant capable of turning the raw material into finished material to meet the specifications of the Board of Water Supply of the City of New York, the requirements calling for rock of two broad sizes, *i.e.*, from ¼in. to ¾in. and ¾in. to 1½in., together with natural sand. The proportions of these materials for a batch are approximately 0·34 cubic yard of ¼in. to 0·42 cubic yard of 1½in. rock and 0·38 cubic yard of sand for each cubic yard of concrete, containing two barrels of cement. The situation of the deposit is on a plateau adjacent to Vernooy Creek, and largely permits the processing of the raw material by gravity flow. The creek has furnished a convenient source of essential water. A power shovel does the excavating of the till and motor lorries move the material to a grizzly, from which the rock, ranging from pebbles to large field stones and sand, drops to a gyratory primary crusher and thence goes onward to two gyratory secondary crushers, operating in a closed circuit. From thereon screens size the material and a Dorr classifier and a hydro-separator wash and size the sand. Conveyors and bins receive the finished products. The plant is a flexible one and has a capacity of more than 200 tons an hour of finished material, and when operated on two eight-hour shifts it has a capacity of approximately 38,000 cubic yards of gravel and from 18,000 to 20,000 cubic yards of sand a month. During the dry period of the 1941 summer, when the creek had a greatly reduced flow, the volume of water pumped from Shaft 2 was sufficient to make up the shortage of the stream flow. The plant is not operated during the winter season, and storage piles strategically established take care of the demands at the three shafts where the placing of concrete goes on continually. This is but one other instance of how all work on the Delaware aqueduct has to be carefully co-ordinated to maintain steady progress.

New S.A. Steel Works.—Despite war conditions the steel works to be built for the South African Iron and Steel Industrial Corporation near Vereeniging are making progress. Orders have been placed in America for the complete plate mill, which will be a single-stand four-high reversing mill, having rolls 38in. and 52in. diameter by 110in. long, capable of rolling plates up to 8ft. in width, together with a slab reheating furnace, auxiliary electrical equipment, and plate shearing machinery. The main electrical equipment, comprising the high-tension switchgear, transformers, rotary converters, mill driving motor, and its accessory equipment, will be supplied from England. The cranes for the whole of the mill department have also been ordered from England, but in certain cases the structural steel work will be made in South Africa from the company's own material.

Canadian Locomotive Experiences

By EDWARD H. LIVESAY

No. VI—*(Continued from page 275, October 2nd)*

UNDER way again, from the Great Divide—Fig. 11—there were 77 miles of almost continuous down gradient and level in prospect, beginning at Stephen, to Beavermouth, at the foot of the Selkirks, and the engine began drifting at once towards the Spiral tunnels, which I intended to negotiate on the "breastbeam" (*Anglice*, bufferbeam), so the camera was prepared. Passing Hector, the train entered narrow cuttings blasted out of the solid rock. I could both see and feel the track dip downwards; it was rather like the sudden plunge of a car on a switchback. The brakes went hard on, and the engine slowed to 7 or 8 m.p.h., cautiously feeling its way down the twisting track. The scenery is glorious here—what a place for a movie camera with unlimited film! Towering mountains soar up into the blue on every side; precipices drop sheer into the valley; the metals twist and turn, turn and twist, and I lost all sense of direction, boxing the compass in an effort not to miss anything. At last the metals could be seen disappearing into a black hole in the mountain side, and the camera clicked as we neared the board marked "Yoho," the beginning of the mile stretch to the station (Fig. 12). In this picture, too, is a "gallows," which I mentioned in a previous article as being placed near a bridge or tunnel to warn trainmen on the car roofs that danger is near, and to take cover. The transition from warmth and bright sunlight to the cool, damp darkness of the tunnel was piquant; the engine sank down, down through the concrete-lined bore, flanges grinding and squealing on the continuous curve, bell tolling, the headlight shining on the wet walls. There was no choking sulphur fumes this time, no suffocating blacked-out cab; it was just a pleasant and novel descent through the cool, echoing cavern which I was really enjoying, when suddenly, before I could do anything but protect my camera, I was carried firmly and deliberately through a sheet of water falling from the roof, and then, with no time to decide whether to swear or laugh—so I did both—through another. This explained Flegal's insistence—it was the nigger in the wood pile! Shaking my sopping feathers, I was carried out into the warm sun again, and at a somewhat increased speed across the Kicking Horse River—see diagram in No. II—the train slowing as the second Spiral was approached. The passage of this was a repetition of the first, but minus the shower baths. Out, and again over the river, the speed rises to 25, to be checked vigorously for an S bend, the gradient still being about 1 in 48. Through a short 180ft. tunnel and a snowshed, and it is possible to look down on to the Kicking Horse far below, where, no longer a mountain torrent, it wanders about in many beds through a field of yellow mud. A tremendous drop! A few minutes later we are alongside it again, coming to a stand in Field Station at 1.25 p.m. O.T., after dropping 1265ft. in the 14 miles from the Divide, at a speed of 18·5 m.p.h., which shows how carefully the descent had been made. Have counter-pressure brakes gone out of fashion? There ought to be quite an opening for them in the Rockies—a good deal of metal must have come off our brake shoes. The crew changed at Field. Was there a twinkle in Flegal's eye, or did I only imagine it? But, like Brer Rabbit, I lay low and said nuffin'.

Leaving at 12.40 p.m.—an hour is dropped here, and Pacific time adopted—with enginemen Carmichael and Fitzpatrick, the Kicking Horse was followed to Golden through a gorge so narrow in places that there is only just room for river and track (Fig. 9 *ante*). "No. 5925's" riding was excellent, but on mentioning to Carmichael the way the deck of the engine on which I had travelled east had vibrated in time with the throw of the side-rods, he said: "That must have been '5926.'" On looking up my notes, it proved to have been even so. Evidently "5926's" balance must be a little out, individually. I have never noticed this vibration on any other of the class.

The automatic signalling used on the C.P.R. has been mentioned before, but it has not been described. It is in use along these B.C. divisions, and I obtained the following condensed details of it, which are of interest. The old semaphore type signals have been replaced at most points by the colour-light, or searchlight, pattern, in which indications are given both day and night by three lights—red, "stop"; yellow, "caution"; and green, "proceed." This particular form of signal was first used by the C.P.R. in 1927 on a section of double track between Streetsville and Guelph, in Ontario. It proved so satisfactory that its use was rapidly extended, no more semaphore signals being installed since, as the older type needed replacement, the new searchlight pattern took its place, and in 1930 became standard on both eastern and western lines.

The searchlight signal employs a single-light unit, consisting of a concentrated filament lamp, with a filament located at the focal point of an elliptical reflector, which collects approximately 80 per cent. of the light rays from the lamp, concentrating them at the second focal point of the ellipse. At this point, which coincides with the focal centre of a clear optical lens, the light passes through a miniature coloured roundel, enters the lens, and emerges as a substantial light beam, having an effective range of vision of 3000ft. to 4000ft. in bright sunlight. The three coloured roundels—red, yellow, and green—are carried in a member or vane moving in a plane at right angles to the light beam, and actuated by a standard relay of the three-position type, so arranged that when de-energised it will assume the central position, due to gravity, and show a red indication. The relay also operates contacts, repeating the three positions of the signal, a valuable feature which was present in the semaphore signal, but was not a feature in other forms of light signals, the latter depending on auxiliary relays for this purpose. In other forms of light signals it is not possible to use a reflector, owing to the danger of the headlight beam reflecting back to the enginemen, giving what is termed a "phantom indication," which may cause confusion or even a false signal. This danger is not present with the searchlight signal, as even if it did occur, the reflected light is of the right colour, having passed through the correct roundel. The use of a reflector enables a smaller wattage lamp to be used, though the range is not reduced, resulting in economy.

FIG. 11—THE GREAT DIVIDE

Automatic signalling means the division of a railway into a series of consecutive block sections, and the location of the signals depends on several factors, such as the density of traffic and physical characteristics—gradients and curvature—which affect the ability of an engine to start a heavy train after having been stopped by signal. The chief purpose of automatic signalling is to increase operating efficiency, by speeding up traffic, increasing track capacity, and so on. The risks of collision (both head-on and rear-end on single track), broken rails, open switches, cars fouling the track, &c., are greatly reduced by providing a space interval in the case of the first and detecting the others.

When automatic block signals are used on double or multiple tracks, protection is generally provided only for trains moving in the established direction, except in certain cases where density of traffic can be increased by having one or more of the tracks signalled for traffic in both directions. The C.P.R. has a section signalled in this way between

Windsor Station, Montreal, and Glen Yard, in the suburbs, where the third track is signalled in both directions. In the first single-track installations, the method of working was what is generally known as the "overlapped control," in which the "Stop" control of the signal was overlapped—the control of a signal would extend to the second signal in advance of it, or nearly so. This was necessary to give protection against opposing train movements, but did not permit following train movements from signal to signal. This lead to the development of the "absolute permissive block" system by the General Railway Signal Company. This was a decided step in advance of single-track signalling, and the first installation in Canada was on the Toronto, Hamilton and Buffalo Railway. In this system the train is given an absolute block from passing track to passing track, against opposing trains, and a permissive block, signal to signal, for following trains. This permits almost equal facility of operation for following trains as in double-track operation, because the direction of traffic is established by the train that first enters the block. Trains may then follow as if the single track was one of the two main tracks of a double-track line. All of these trains must pass out of this section between passing tracks before the signal indications will permit a train in the opposite direction to enter the block. This train, in turn, will then establish the opposite direction of traffic, and trains may follow it, signal to signal, with the same facility as in the first case.

The control circuits of this "absolute permissive block" system are ingenious, but do not require any appliance other than those ordinarily used in automatic block signalling. They are so arranged that the system restores itself to the normal position as soon as the block is clear, regardless of whether or not a preceding train or trains have passed through the block. If a train enters an intermediate spur or siding, and stands clear of the main track, the system restores itself, so that another train can leave the passing train at either end of the block. When the train leaves the spur or siding, it establishes its direction on passing the first signal, and the signals governing movement in the direction established display "Proceed" or "Stop" indications, according to the condition of the blocks in advance; signals governing opposite movements display "Stop" indications. This system is flexible, and can be easily arranged to provide any special requirements necessary.

The use of "train orders" on automatic signalling territory is decreasing, and a step further in this direction has been made by the introduction of the centralised traffic control system, in which the despatcher has direct control of all traffic. This combines all the functions of control into one centralised unit. Protection, direction, and the actual operation of the switches for the passage of trains are brought about by this new system, which, however, is new only in the sense that it co-ordinates various signalling and interlocking functions of proved reliability previously used individually. By this method all trains are moved by signal indication at the will of the despatcher, regardless of time-table superiority and without train orders. Trains are not held waiting for the transmission and delivery of orders at points along the route; the movement of through trains is expedited, and local trains can spend a larger proportion of their time in productive work. Wherever there is a bottle-neck, whether on single or multiple track, this system gives facilities that will postpone the building of additional track for many years, and the cost is but 10 to 15 per cent. of what it would be to build an additional main track.

The operation of the system is simple. The control board or machine, which is small and compact, is placed in the despatcher's office, and on it is a track model of the territory covered. Immediately below it is a row of small levers for the working of switches and signals, the position and operation of all switches, and if need be the signals also, being indicated to the despatcher by lights on the control board. The passage of a train in or out of a section at each end of a passing track is automatically indicated, and also registers the time of passage on the train graph, which in this system replaces the despatcher's train sheets.

The run through the Columbia Valley calls for little description, as it has been dealt with in preceding articles. A pilot engine came on at Beavermouth to assist us up the heavy incline on the eastern slopes of the Selkirks, through the Beaver Canyon, which is very wide and deep, the mountains on the far side being so thickly covered with firs that it looks as if one could not put one's fist

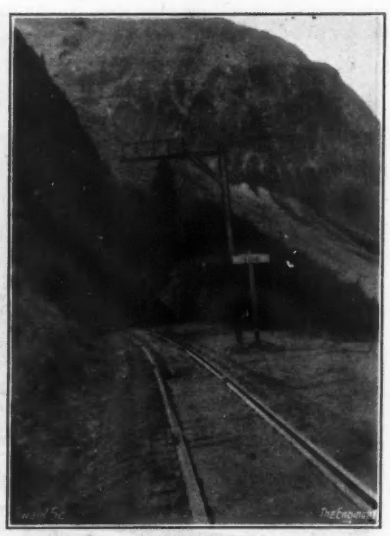


FIG. 12—ENTRANCE TO UPPER SPIRAL TUNNEL

between them. The pusher came off at Stoney Creek, and the sun went behind the mountains, the air immediately becoming deliciously cool, as the train, protected by their bulk, ran on through the shade to the eastern portal of the Connaught tunnel. The passage of this is pleasant, as it is double-tracked, high and well ventilated, feeling almost chilly after the sultriness of the air outside. It takes about 12 min. to go through the 5-mile bore. The fact that there is a mile or so of rock over one's head is a comforting thought; once inside, avalanches, air raids, and other absurdities, ancient and modern, could be treated with equal indifference. The tunnel was not built merely to reduce gradients, but to eliminate a very troublesome piece of line through Rogers Pass, notorious for avalanches, tremendous snowfall — known to reach 45ft. on occasion—heavy gradients, vicious curvature, snowsheds, and other disabilities, which all combined to bring about costly and dangerous train operation. Before the tunnel was built, the peak altitude of the line in the Selkirks was 4351ft., reached by inclines up 1768ft. in 45 miles, and down 2837ft. in 22 miles. Going west from the summit, the line dropped 637ft. in 7 miles down to the Illecillewaet River, making two S bends *en route*, with Glacier Station in the middle. Now the summit is at 3778ft., the approaches on both sides are much easier, and the station is just outside the western entrance of the tunnel. This was driven from a preliminary bore 50ft. to one side, permitting thirty-two faces to be worked simultaneously. It is by far the longest tunnel in Canada, those under Vancouver and Mount Royal, in Montreal, coming next, a long way behind.

Going down from Glacier Station, Carmichael pointed back to the traces of the old route far above and behind, zig-zagging across the face of the mountain; to derelict bridge piers, and the blue-green mass of the lovely Illecillewaet glacier, from which the station takes its name, up among the clouds. There are several snowsheds on the present route, one very long, as avalanches have by no means given up their old bad habits, and still come thundering down the slopes occasionally after extra heavy snowfalls. Carmichael mentioned having been the engineer of the plough train that was swept into the river a few years ago, killing two men, and showed some of the wreckage of his unlucky outfit lying half-submerged in the rushing water, and just visible among masses of underbrush. There was a great bare gash on the mountain side down which the slide had roared, and down which they are still so apt to come that the track has been shifted to the other side of the river out of their probable path, in what is known locally as the Downie diversion. For 2 miles the metals were transferred from the base of mountans with a southern exposure, across the river to the foot of a well-timbered slope with a north aspect, where the sun cannot get at it, nor melt the snow above it, thus loosening its foothold on the treacherous rock. And so "The Dominion" continued to Albert Canyon, an awesome vertical-sided rift near the track, where the trains stop a minute or two to allow passengers to peer over the edge, down into the river boiling along 200ft. below. It was delightfully cool now, in the shadow, though the sun was still pouring across the canyon over our heads on to the upper slopes of the mountains, and glittering on the snowy peaks that here are white-capped all the year round. It was tantalising to look down from the cab into the icy Illecillewaet, foaming alongside; how refreshing a plunge would be, after twelve hours in the cab. But Revelstoke was near, a bath, and change. I was stopping off there thanks to Carmichael's hospitality. "The Dominion" came to a stand there at 6 p.m., after having covered the 125 miles from Field, with about a dozen stops, in 5 h. 20 min., 23·5 m.p.h. No, perhaps it does not sound very impressive, but it is actually very fine work, when you take into consideration the gradients, curvature, and the 1100-ton load. And with that the story ends, the train with which I ultimately carried on to Vancouver being No. 7, the second section of "The Dominion." As it turned out to be hauled by an engine of the old "2700" class, which I described three years ago, I made the trip in a sleeping berth instead of the cab, and for once in a way deliberately missed the whole of the Fraser and Thompson canyons. One concluding word of advice. If you should travel through the Rockies at any time—which you really ought to do—and take chances on the pilot, be sure to wear a raincoat in the Upper Spiral—the roof leaks!

I am greatly indebted to Canadian Pacific Railway officials for their invariable courtesy and help, without which these articles could not have been written, and for permission to make the necessary observations in the cab.

In particular, I wish to thank Mr. Bowen (C.M.E.), Mr. March (Montreal), and Mr. Coleman (Vancouver), for photographs, drawings, and data of various kinds, which have done much towards rounding out the articles. The consideration of the many enginemen, and their kindness, which I have tried to acknowledge, have been very much appreciated.

Similar thanks are due to Canadian National Railway officials, in connection with the articles dealing with that company's system, with which I would like to couple the name of Mr. Deacon (Montreal).

Men and Machines*

By SIR LOUIS BEALE

I WONDER if it is difficult for engineers or wives of engineers not to think in terms of machines, and indeed of men as part of machinery. I remember when technocracy was a fashionable doctrine. The engineer was to run the world; he would organise everyone's life; his machines would do away with all unnecessary labour—nothing, in fact, would be done by hand. It was true that the engineer was then beginning to rule the world, to organise mass production and the use of machinery. There was a danger that he would be regardless, or rather forgetful, of human values and of the things that really make life worth living—truth, beauty—things of the spirit. Where does the engineer stand to-day? What is war teaching us? What lesson is the war teaching us which we must remember in the peace we look forward to?

Let us look back at those pre-war days for a moment. How were the engineers planning the world? They were thinking in terms of more and more goods to be produced, cheaper and cheaper; hours of labour were to be cut down correspondingly; the world was to be a place where there should be an abundance of leisure and an abundance of necessaries and, indeed, of luxuries for everybody.

Had the engineer forgotten something? He had forgotten the harm that a few evil men can do to the world. He had forgotten how easy it was for a criminal with a gift for leadership to lead the common people astray. How many of us took for granted that another war was impossible, that, at all events, nothing could touch this great country, protected as it was by two oceans? And some in Britain felt the same way about our own little island. And so we—both of us—slipped into the war unawares. We had concentrated our technical skill on the arts of peace (not very efficiently, if one took a broad view of the whole world), and we had failed altogether to realise the danger of war. War came on us unprepared, unprepared physically and spiritually. From that unpreparedness we have suffered for two and a half years. We were not ready for the war of production, for the war of transportation, or for the war of combat. The critics, I believe, attack the Governments always, in times of war, with the cry, "Too little and too late." Whose fault was it that Britain was unprepared, that France was unprepared, that America was unprepared?

In a democracy it is the fault of the people, not of the Governments! By and large a country gets the Government it deserves.

And so for two and a half years the tide of battle has ebbed and flowed. The story has always been the same—not enough tanks, not enough aeroplanes, not enough ships. Gradually we are making up the leeway; gradually we are meeting our enemies on equal terms. The engineer has now got the chance to do his great part. And splendidly the engineer is doing it. The production of instruments of war is a necessarily slow process. It was only in 1941 that the change over to the full production of aeroplanes of present wartime design was begun in the factories, and it is only in this year that the new models are seen in service in substantial numbers in the squadrons. Of course, I do not mean that no improvements have been made in modifying existing types, but the "Spitfire Mark V" and the "Hurricane Mark II" are only modifications of the original "Spitfire" and original "Hurricane." The fact that your "Airacobras" are being flown direct to the battle fronts is, perhaps, the most striking advance of recent months.

Ebb and flow, flow and ebb. It is only the unconquerable spirit of man, the love of liberty that seems part of the soul of every true man, that has stood up to the flow of evil that has threatened now for three years to engulf the world. What has stemmed that flood? As much as anything else, the brave men and women who carried on beneath the hail of German bombs in Britain in September, 1940.

And the fighters in the air who broke the power of the German Air Force? Yes. But I honour equally those unsung heroes of London and Plymouth and Coventry—plain men and women who faced death and mutilation under intense bombing rather than surrender.

THE PRESENT

But let us glance around at these various fronts to-day. Now that the engineers are coming into their own, everywhere we see mechanised warfare, but everywhere also we see human skill, human courage, human endurance, human fortitude. Sometimes I wonder whom I admire most among the fighting men. Personally, I put in the front rank the ground crews, officers and men, engineers and mechanics, who are servicing aeroplanes and tanks in the Libyan Desert. No air-conditioned factories for them, probably not enough tools, no shade, the temperature running to 120 deg., and always the chance of hostile attack from the air. The work goes on, night and day. Not enough water; enough rations, perhaps, but every mouthful has to be won after a battle with flies. You gentlemen can picture better than I can what servicing an aeroplane or tank means in the desert, where the only hangar—the only workshop—is perhaps a tent on the sand. Upon the absolute efficiency of the machines depend the lives of the men who fight them—depend also the very results of the battles.

It is true that in Britain to-day the ground forces of the R.A.F. are not harassed by German bombers as they were last year, but to organise these great sweeps of more than a thousand aeroplanes over Cologne and Essen there are perhaps a hundred thousand men nursing these big bombers, feeding them with gas and bombs, going over their intricate machinery to ensure that all is working smoothly. Before the Essen raid some of our men had been working forty hours at a stretch continuously. They may not have the thrill of joining in the long procession majestically sweeping over the sky to Germany. They do not run the risks from anti-aircraft fire and hostile aeroplanes, but it is their work that helps bring victory nearer.

We know the time will shortly come when American machines with American crews will join their British comrades in the air over Europe. We know they will show the same devotion, the same courage, the same technical skill.

I say we *know*, because American soldiers, seamen, and airmen have already proved their worth in so many quarters of the globe. We know what American soldiers have done in Corregidor, what American sailors did in the Battle of the Coral Sea, what American airmen are doing over Burma and in China. There, in China, more than in any other theatre of war, do we see how the great human virtues shine resplendent, when equipment is far inferior to that of the enemy.

You will notice that these examples I have just quoted are taken from events of the last few weeks. But one short year ago the whole of South-Eastern Europe was being overrun, despite the gallantry of the Greeks, by the armies of the Germans and the Italians, fully equipped with every known instrument of warfare. But the gallantry of the Greeks and their Allies was not wasted. The gallant resistance in Greece and Crete upset Hitler's timetable, with the result that his invasion of Russia was made six weeks too late.

Six or seven months ago Japan was bowing from the waist in Washington and at the same time piling up stores of war material in preparation for her treacherous attack of December 7th. A year ago "too little and too late" was still true as the war spread to the Pacific. But now at last we see Americans fighting with equipment equal to that of the enemy—with a courage, a skill, and brainwork that makes the final result certain—Midway—the combined triumph of American Navy, Air Force, and Marines.

Thank God your factories are now beginning to approach the output needed. Things *are* changing. Never again shall we, the United Nations, be obliged to trust to courage and endurance alone without the tools with which to fight.

Behind the firing line in these factories in which you gentlemen—the mechanical engineers—stand as the officers in the great army of production, what are the qualities we need to-day? Is it only engineering skill, only mechanical proficiency, only inventors' genius? No, you know as well as I do that it is morale that counts—morale in all your great work.

Are we superior to our enemies in technical skill and in inventive power? To me this is a basic problem of the war. If free men, working with free minds in a free country, cannot think better and work better than slave men with enslaved minds, in a slave country, then our boast of democracy is not worth having. Do you believe that the men of science, dragooned by Hitler in universities where freedom of thought is forbidden, can produce better results than the men of science in universities of Britain and the United States? Do you believe that the engineer who has to click his heels to every Gestapo policeman that skulks around his factory can produce a better output than one of you? Do you think that it improves a man's work to be treated like a dog? To be forbidden to listen to foreign radio? To be frightened to whisper his opinions, even to his wife and children?

* An address delivered at a dinner at the Hotel Statler, Cleveland, Ohio, June 9th, 1942, during the semi-annual meeting of the American Society of Mechanical Engineers. From *Mechanical Engineering*, August, 1942.

To be deprived of the right to worship the Almighty in the way he thinks best? If you believe, gentlemen, that slavery of body, mind, and spirit makes a man and woman better human beings, better for work as well as better for play, if you believe that, then what are we fighting for? I believe, and I know you believe with absolute confidence, that we can beat the Germans in factory and workshop as well as we surely shall on the field of battle. I believe we can do it because we are free men, fighting for the cause of freedom. Morale—morale—*morale!* I believe that *this* is the true foundation of morale—that every one of us shall think of his opposite number in Germany—be he scientist, engineer, draughtsman, greaser, cleaner, or oiler. Let him say to himself, "I am a free man. I can do better work than the guy who is doing the same sort of work in Germany, and I'll show him!" Preach that in the factories, gentlemen—preach that in the factories, and do not fret about what any external influence may tell you you ought to do. Do not feel your patient's pulse every twenty minutes. The heart of the American people is sound. There are too many experts wandering around equipped with stethoscope and cardiometer.

I have said nothing about appealing to fear, to the immediate danger to life that falls not only upon my countrymen and millions throughout the world, but quite possibly on your own countrymen. That danger, as your own leaders assure you, is very real. Even if this fair city of Cleveland were never bombed, the danger to your everyday way of life as well as to your country is just as real. Look at Poland to-day, at Norway, at Belgium, at what was Czechoslovakia! Hitler's plan is real—to enslave the whole world. And so within us all must burn with white, consuming heat the hatred of tyranny, the love of freedom, and the will to work and the will to fight Thus only shall we survive, shall America survive, shall the United Nations survive. Our victory—the victory of the United Nations—is the condition of all else, of all that we cherish.

It is a common phrase to declare, "This is a war of machines." That is not true. It is a war between men, between ideas, if you will.

It is war of production, a war of transportation, and a war of combat. And in production, transportation, and combat, we see constant changes occurring in grand strategy and in tactics as the war continues.

Let me give you an example of the changes in the strategy of the war of production. This is the age of the "interloper"—men who break into old industries and do the job better and faster than it was ever done before. You all know how Mr. Kaiser is producing ships on assembly lines, introducing mass-production methods at a time and in a sphere where they are urgently needed. He is the sort of "interloper" we welcome with open arms.

But it is from England that I can give you the most interesting example, I think, of the disappearance of competition between firms in the same industry and a "pooling" system under the control of a parent company.

I have just received from a reliable source some account of what a large garage company in a town in Kent are doing in the way of war work.

They have brought into active and continuous production 100 small firms in the neighbourhood (chiefly garages), of which 52 employ less than ten persons, 36 between ten and twenty-five, and only 17 more than twenty-five.

The group has completed most satisfactory work on gun carriages and ammunition. They have produced shells, bomb parts, small-arms, gun and carriage parts, including 40 mm. Bofors and 3·7in. anti-aircraft gun parts. Reports of the inspectors are excellent. The company are now unable to accept all the work that is offered them. The turnover has risen from nothing to 50,000 dollars a week; 99 per cent. of the work passes inspection.

The output is secured by relatively unskilled workers and simple tools. Of the 2000 employed, 1300 are women and 700 men; 1800 are unskilled and 200 skilled. Many of the small shops are working three shifts. All responsibility for finance, accounting, and inspection rests with this garage company in a once peaceful little country town.

It is this sort of co-operation in industry that enables me to give you good news of how production in Britain to-day compared with the output in those feverish summer months of 1940, the days after Dunkirk. Here are some comparisons—first of all, tanks. We are turning out twice as many to-day as we did in August of last year; three times as many as in February, 1941, and five times as many as in July and August, 1940. This achievement means more if you remember how difficult a tank is to build. We had to make the best of what we had got. So the tanks of the type we needed were broken down into 8000 bits and pieces, and then 6000 firms, ranging from big plants to backyard garages, were enlisted to make one or more of those 8000 parts.

Let us turn to the war of transportation. Again we see new methods of attack and defence developing as the war proceeds. On the side of attack there is the pocket submarine and the long-distance bomber; for defence the submarine chaser and the long-distance reconnaissance plane. Despite the gloomy news that confronts us daily, I believe we are winning the war of transportation, winning it slowly, it is true, but winning it surely. We shall win in the end, even though we may have to draw in our belts in this country—not as tight as they are drawn in Britain, but still, pretty damn tight.

We are losing shipping very seriously along the coast of this country. Across the Atlantic and in the Arctic Ocean we are doing fairly well. In the Mediterranean and the Pacific our enemies are doing worse than we are. There is another side to transportation—the railways. I wonder what trainloads the traffic superintendents in Cologne and Essen are despatching this week? Is the freight yard at Cologne a traffic yard or a junk yard? I wonder how far supplies to the German Army are running steadily up to the Russian front. So, as we take a hurried glance around the whole world, it seems to me that the battle of transportation has also its ebb and flow. Remember, the losses are not all on our side. Still, ocean transportation remains a very serious matter for us—very serious indeed.

And the battle of combat—have you noticed how the military experts have been consistently wrong for the last three years? Did anyone believe that China could have withstood the onslaught of Japan for five years? Whoever imagined that the Italian Empire in Africa would fade away before the attacks of a few thousand British and Belgian troops? Are you aware that a Belgian colonel at the head of two battalions picked up seven Italian generals and their men as their prisoners? Whoever prophesied that the Italian air force, the *regia aeronautica*, would crumple before the British flying men? Did anyone believe that Malta would hold up against 1500 raids? Of all the bubbles burst in this war, Mussolini's toy balloon has made the most astounding pop of all. But take two of the more important combatants, Britain and Germany, and the judgment of the critics upon them. It is twenty months since those critics prophesied the destruction of Britain within six weeks. Or take Russia—the magnificent. It is only ten months since the critics declared that the German Army would cut through the Russian like a knife through butter. You would not expect me, a poor humble civilian, to evaluate the military position to-day. I am not guessing whether Japan proposes to invade India, or Australia, or to endeavour to complete her conquest of China, or how far the attack on Alaska is merely a piece of bad psychology, an effort to frighten the American people. I do not propose even to discuss the possibility or probability of opening up another front. Of course, we should all like to see it, but possibly you know that it takes 14 tons of shipping to transport each single soldier with his equipment across the sea. I am thinking, of course, of a fully equipped army, and not just the gallant little commandos with their wasp-like attacks on German posts. I do not know the answers to any of these military questions, gentlemen. Quite honestly, I have too much to do in my own job and it leaves no time to inquire into such questions. All we civilians have too much to do to inquire into such questions. If we do our own jobs properly, we shall have no time to tell the generals and admirals how to do theirs. All I know is that we, the anti-Axis nations, are united as never before, that our purpose is firm, that we have won the battle of production, that we are winning the battle of transportation, and we shall win the battle of combat.

This war has taught us, I think, that a mere mechanised world is a hollow dream. We know it is man that matters. We are bound to use machines to assist him, even in the most devilish of all tasks—the destruction of his fellow-creatures—but we have learned quite definitely that man must remain the master—the machine must be his servant. Courage, brains, and endurance will win this war—courage, brains, endurance and sacrifice in the firing line and behind the firing line. There are in Great Britain 33,000,000 people, men and women between the ages of fourteen and sixty-five. Out of those 33,000,000, 22,000,000 are directly engaged in war production. These figures speak for themselves; they tell you what life is behind the firing line in Britain.

And after the war we shall need, perhaps more brains, more courage, more endurance, and sacrifice. What will the engineer do? How will he control his machines when victory comes? How can we use this amazing power of the engineer over Nature, these aids to human progress? Let us consider the future as we see it and the tasks that will lie before the engineer.

The Future

You have doubtless pondered in your minds this problem of post-war reconstruction. You have visualised these huge plants now devoted to war work. You have seen in your minds the possibility of machinery lying idle and the men out of work. You have thought, too, of the millions of soldiers—4½ million for this country alone—longing to get back to civilian life, unsettled, of course, and feeling that they have suffered and that now they have a right to reap the fruits of victory and the blessings of peace.

Have you thought that the same will be happening all over the world? How many men are there to-day under arms? Shall we say 15 million? Shall we say 30 million?

And how many are there engaged in war production. Shall we say 300 million? And how many women are there thus engaged? Millions! In Britain to-day there are 1¼ million women working in the aeroplane factories alone.

All human beings the world over have got to be helped back to a reasonable human existence, if we and our children are ever going to enjoy peace and contentment. Most certainly, we shall not leave the Germans and the Italians and the Japanese free once again to form plans for world conquest. Never again will we allow a Hitler or a Mussolini or a Hirohito to weave their loathsome plots, to plan treachery, to prostitute science to the insane desires of men drunk with power. No, ladies and gentlemen, we have learned our lesson. Even if it takes a hundred years of watching under arms, we will see to it that such villainy shall never be permitted again upon this earth. We shall remain armed watchers over the peace of the world until the hearts of these people—these Germans, these Italians, these Japanese—are cleansed from the evil infection that now corrupts their very souls.

Do you ask me how we shall plan the world anew? The time is not ripe for blue-prints. We can only sketch the very broadest outline. Let us try to establish three or four basic principles for this world of the future. First, we must recognise the inherent equality of man. I do not mean that all men are equal in body and mind. You know as well as I do that they are not, but I do believe that in our new world we must give all men equal opportunities—above all, opportunity for freedom. Once, we used to talk of the "white man's burden"—the duty of the white man to guide, to control, to give justice to the "lesser breeds without the law." That idea is dead. All the men and women of all countries will claim freedom as their inalienable right. Millions of the peoples of the United Nations have fought and suffered and died for this cause. And when our Allies sit with us at the Council Table of the World, they will say: "We have fought, we have suffered, we have spilt our blood in the same cause as yours. We have shown ourselves as men."

Dare we of the Western World then say to these, our Allies: "But look at our machinery! Look at our factories! Look at our conquest over Nature! We have been the pioneers of progress, the standard bearers of civilisation." I fear, gentlemen, that the answer may leave us speechless. "Look where your civilisation has led us all." In all humility, then, shall we gather around the Council Table. In all humility, but with infinite courage, we shall join in the greatest task of all—to plan the world afresh.

Think again for a moment of the Council Table of the World—when victory comes.

The English-speaking nations will be there. Britain with her age-long traditions and long Colonial experience, America with her stalwart frontier spirit ever burgeoning within her and her genius in industry, Canada with space and spirit for a great nation, Australia and New Zealand, the testing grounds for social experiments, South Africa with her problems of 7 million coloured to 2 million white. Europe will be there—maimed, ravaged, ruined Europe—blazing with hatred for her tormentors. South America will be there. China will be there—China the heir of thousands of years of civilisation. India will be there—India at the parting of the ways—wondering whether to westernise or to hold fast to her old traditions. Russia will be there.

The representatives of 1500 million human beings, victors united in war—united in victory—all will be there. Shall we remain united in peace? The bonds that unite us have been forged in the furnace of suffering, tempered by the tears of starving women and children, hallowed by the blood of heroes. These bonds will hold us together, until we are certain beyond peradventure that never again shall greedy tyrants, for their greed and their selfish ends, engulf our world in war. For it is our world, the world of plain simple men and women who have borne the burden and heat of the war. It is our voice, the voice of the people of the whole world who will say, "Never again." Let the rulers beware if they do not take heed. So far we shall remain united. But in shaping the new world, will our unity stand the strain? Yes, we must and shall be united in peace.

We are all bound by the Atlantic Charter. What has been promised by the Atlantic Charter? Economic equality; that is, access to raw materials, an approximation to freedom of trade. The corollary is sure and certain. It is a hard gospel, but I believe it is inevitable, that all nations and all industries within nations must live by merit and not by favour. That means brains, courage, endurance, and sacrifice.

The elimination of large-scale unemployment must, I think, be undertaken by some form of international action. The great manufacturing countries, such as the United States of America, Britain, and Germany, have largely solved the problem of mass production. But have they solved the problem of distribution? With maladjusted distribution comes loss of purchasing power and corresponding unemployment. Somewhere we must cut into this vicious circle. Somewhere we must ensure that workers are no longer left to starve amidst plenty, that those ready and willing to use their hands and brains shall not become centres of righteous discontent against a system that fails to provide a living.

You will notice that I take unemployment as a basic problem in post-war reconstruction. What a man wants, be he white or black, yellow or brown, as his due reward for work well done, is security, freedom from fear, from fear of sickness, from fear of old age, from fear of poverty and want for himself, for his wife and children. That security, that freedom from fear is only possible in a world considered as a whole. We know now that it is futile to think of half the world as happy, content, and prosperous, and half the world as idle, angry, and poor. We must try to give this security, this freedom from fear, to all the peoples of the world—not just to our own peoples. Indeed, unless we tackle the problem of unemployment as a world problem no nation itself will be free from the curse of unemployment—we must all be well or many of us will be ill, in the economic and social sense. Do you realise the poverty of South-Eastern Europe?

Do you realise that a Bulgarian or a Rumanian peasant has perhaps 5 or 6 dollars a year with which to buy goods that are not produced on his own little farm? Do you know how millions of Chinese along the Yellow River are in constant danger of seeing their livelihood swept away by sudden floods? Do you know what riches await the world in the Amazon Valley if only science and engineering skill could be applied to that rich area? It is in tasks such as these that the engineer will play his part in world reconstruction. Some international body, perhaps an International Bank, must provide the capital, but the engineer with his European and American knowledge and skill will build and supervise these giant plans that will give security to the poverty-striken peoples who live to-day in constant peril of starvation and destruction.

Far be it from me to suggest that every nation shall become industrialised, that we wish to see China dotted with factories, to see the primitive arts of Java and India swamped in a flow of mass-produced goods. I do not believe that happiness consists merely in collecting property.

What, then, is the task of engineers in this brave new world of ours? First and foremost, his profession gives an outlet to the adventurous spirit of man. We shall need it more in a world of peace than in a world of war. It is a spirit that we must foster. It is a spirit we must sublimate—we must turn it to a higher cause than the destruction of one's fellow-men.

The engineer and the scientist have their great adventures in the search after truth, in the conquest of nature. There are victories to win over famine, over flood, over drought and pestilence. The engineer can relieve men—all men, not merely his own countrymen—of dull, laborious toil.

From that toil the engineer does save, can save, and will save humanity. He will lead humanity to happier, nobler, and freer lives by his conquest over Nature. He will open up a realm of peaceful living as yet undreamt of. But he will not control the world. He will not mechanise the human soul. He will realise that there is more to life than creature comforts, that man is ever striving toward the Infinite, toward a higher goal than the mere satisfaction of his bodily desires. We need a new balance of values, a new order of ideals, a new standard of happiness. We shall never rest content until the whole world can enjoy this new balance of values, this new order of ideals, this new standard of happiness, and in building up the new world the engineer will always play a great and noble part. His motto will be—

> Keep ye the law—
> be swift in all obedience—
> Clear the land of evil,
> drive the road and bridge the ford.
> Make ye sure to each his own
> that he reap where he hath sown;
> By the peace among Our peoples
> let men know we serve the Lord!

It is for that we are fighting; not for glory, not for wealth, not for power—but for peace among the peoples. In the calm certainty that our cause is just, we shall press ardently forward toward our goal. The path is dark and toilsome. Like Christian in "Pilgrim's Progress," we have escaped from Castle Doubting. We have vanquished Giant Despair. We may yet have to pass through the Valley of the Shadow of Death. But already I see the dawn breaking over the Delectable Mountains. I see Victory—I see Peace among the peoples of the whole earth.

PAPER CONTAINERS FOR CANNING.—A new method of manufacturing paper-bodied containers on existing can lines has been developed by the American Can Company. As soon as it has been thoroughly tried and perfected through actual production, the company will make the process available to the entire canning industry for the duration of the war. *The Iron Age* says that heavy paper similar to that used for milk containers will be cut to size, lithographed on the regular presses, and fed to the can line. The new containers will be available to the extent that black plate is made available for the manufacture of ends. Producers of dry products will be the principal beneficiaries through the new development, though a few liquid products, other than processed food, may also be affected. Apart from the potential saving of steel and tin, the process has the advantage of requiring no new machinery. Not only may existing can lines be adapted for it, but users of the new containers will be able to fill them on existing packaging machinery. In appearance, the paper containers will closely resemble the cans they replace.

The Engineer

OCTOBER 9, 1942

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NOTICES TO READERS

The fact that goods made of raw materials in short supply owing to war conditions are advertised in this paper or described in its editorial columns should not be taken as an indication that they are necessarily available for export.

With a view to the conservation of paper, readers are advised, in the interests of all concerned, to place a regular order for THE ENGINEER with their newsagent or direct with the Publisher.

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CHANGES OF ADDRESS

*** *Will Subscribers please note that in all advices regarding changes of address it is necessary to have* **both old and new address,** *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

Postal Address: "The Engineer," 28, Essex Street, Strand London, W.C.2.

Telegraphic Address: "Engineer Newspaper, Estrand, London." Telephone: CENtral 6565 (10 lines).

WAGES

ALARMED by the rapidity with which prices are rising in America, Mr. Roosevelt, fortified by the "Anti-inflation Bill," has made an Order that all wages shall be stabilised at the rates not exceeding those obtaining on September 15th, and has at the same time fixed salaries and has directed that the control of profits be examined. This Order must be regarded as an experiment, one of the most interesting and pregnant economic experiments of the war. Many people desired to see it tried in this country. They contended that wages and incomes should have been frozen at the amounts prevailing on the outbreak of hostilities. The Government, after careful study, decided against it. Mr. Roosevelt has had the advantage of our experience, and he is taking the opposite course. Conditions in the United States and in Great Britain are not the same. What may be possible and desirable there may be undesirable and next to impossible here. Nevertheless, the progress of events in the first few months under this Order will be watched with the closest attention by British economists.

The object of limiting wages and incomes is to check inflation. If there is no control, the vicious spiral begins. High wages mean more money to spend; more money means higher prices, and higher prices lead to higher wages. There is no end to the circuit once the natural restraining forces have been removed, as they are in wartime, with its inevitable cessation of normal market restrictions. But inflation can be kept in check in other ways—by limiting the number of articles that are available for purchase, by fixing prices on essential goods, and by heavy taxation. That is the method being employed here. It must be admitted that it has met with almost complete success. There is, so far, no dangerous evidence of inflation. On the other hand, the cost of living has been stabilised, and, if anything, shows a tendency to fall. Nevertheless, there is a continuous upward movement in wages. We are not concerned here and now with the ethics of high wages and the standard of life of workpeople and of the lower classes of salarians. Such matters are more proper for peacetime than for wartime. The fact is that the wages prevailing in this country are higher than needed to meet the cost of living under reasonably comfortable conditions As Lord Gainford pointed out in the House of Lords last week, the savings made by the working and lower salaried classes indicate that "there has been a margin of profit over and above what is necessary for maintaining the standard of living and the ability of the people to buy what they can, either in the way of clothes or food." Why, then, is there an almost continuous demand for higher and higher wages? The answer given by Lord Gainford, an industrialist of large experience and himself an employer, is, we think, correct. It arises from a sense of unfairness and inequality. If any body of workers sees others receiving a higher rate of pay than they do, they demand an increase. If their demand is granted, the original recipients of higher rates demand another increase—and so another vicious spiral begins.

How far is it safe to allow this process to continue? It is admittedly quite impossible to equalise wages. An attempt to lower some in order to raise others would be contested to the utmost. To raise all to the level of the highest would involve an expenditure before which even the richest country would quail. It seems probable, therefore, that the present method of continual readjustment will have to be allowed to continue. Whether or not that matters during the war is a question upon which difference of opinion is permissible. But the repercussions after the war must not be forgotten. Workpeople and others who receive abnormally high pay now will wish to retain it when peace returns. That can but mean a marked reduction in the purchasing value of the pound. Will it be practicable so to arrange international finance that that reduction will not have a very grave effect upon a country like this, which depends upon foreign trade for its existence?

Men and Machines

IN June last Sir Louis Beale delivered a stirring speech to the American Society of Mechanical Engineers at a dinner in Cleveland. We are fortunately able to reprint this speech to-day from the pages of the official organ of the Society, and we feel sure that it will be read and appreciated by engineers on this side of the Atlantic as much as by those on the other side. Sir Louis Beale, we may recall, is Co-ordinator of Empire and Allied Requirements, British Supply Council in North America. Few men understand international trade better than he, for he has been a Trade Commissioner of His Majesty's Government in a number of countries overseas for many years.

But on this occasion Sir Louis was not concerned with trade. His purpose was rather to direct the thoughts of his audience, and especially of engineers, to the loftier aspects of their vocation. He was embattled, not against the machine, but against the exaltation of the machine to a position which makes it the master of man. "This war has taught us," he said, "that a mere mechanised world is a hollow dream. We know it is man that matters. We are bound to use machines to assist him, even in the most devilish of all tasks—the destruction of his fellow-creatures—but we have learned quite definitely that man must remain the master—the machine must be his servant." Then followed an eloquent plea that no narrow national feelings should be allowed to prevail in the world after the war. All human beings in the two hemispheres must be helped back to a reasonable human existence. In that great work the engineer must play a part of the first importance; he "with his European and American knowledge and skill will build and supervise these giant plans that will give security to the poverty-stricken peoples who live to-day in constant peril of starvation and destruction." "What then," he asked in his peroration, "is the task of engineers in this brave new world of ours?" and his answer was that they must foster the adventurous spirit of man in the conquest over famine, over flood, over drought, and pestilence. "The engineer can relieve men—*all men*, not merely his own countrymen—of dull, laborious toil. He will lead humanity to happier, nobler, and freer lives by his conquest over Nature. He will open up a realm of peaceful living as yet undreamt of. But he will not control the world. He will not mechanise the human soul."

Sir Louis Beale gave eloquent expression to what many engineers are beginning to feel. They are taking a higher view of their vocation and profession and with that higher view comes an increasing desire to play a major *rôle* in national affairs. It is in no small measure the fault of engineers themselves that they have for so long been regarded as little better than "base mechanics." They have not endeavoured to take a large view of the duties and responsibilities of their profession. But a new spirit is stirring and the time is no longer remote

when the counsel of engineers will be sought in the management of world affairs. To that time we must look, and for that time prepare by an extension of the education and post-educational interests of our young engineers. An address like that of Sir Louis Beale opens to them a view of the vast duties that lie before them. It is for them, for the new generation, to see that they are equipped to perform those duties.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

WORKS RELATION SCHEMES

SIR,—In your excellent leading article in the issue of September 18th on "Works Relation Schemes," you rightly draw attention to an idea which, carried into practice generally, is capable of a considerable influence on production.

It is true that in many large engineering establishments the workpeople not directly employed on weapons do not see the connection between their particular job and the war effort, and for this state of affairs managements are mainly to blame.

There is still a widespread conviction that workers and managements must of necessity be consistently antagonistic, which, on one hand, leads to factory executives refusing to take workpeople into their confidence, and saying in effect, "Do as your are told, and don't ask questions"; and, on the other hand, to the workers refusing to help in overcoming difficulties in production on the grounds that extra effort on their part merely increases the profits of their employers.

The result of both attitudes is to hinder production and to intensify whatever feeling of antagonism exists, since both sides become completely immersed in destructive arguments about who is to blame, instead of in constructive efforts to increase production. If Mr. Churchill and Mr. Stalin are able to co-operate against the common enemy, there is clearly no excuse for the present bitter relations between employers and workpeople in many sections of the engineering industry.

It is obvious that the lead must come from the employers and in the works relation schemes you describe there are ample opportunities for works executives to establish some common ground with workpeople without jeopardising any "managerial rights."

To take a concrete instance, the present coal shortage affects everybody, first, as a citizen concerned with the war effort, and, secondly, as an individual with a home to keep warm. Maximum coal production demands prompt delivery of mining equipment, such as electrical switchgear and transformers, for example, which to most workers may seem remote from the war effort. The workers employed in manufacturing such items normally do not know the purpose for which they are required; usually they are just job numbers with certain piecework prices attached.

If, however, every worker knew that this material was indispensable to increase or even maintain coal production, and that delay in completion not only hampered the war effort, but also lessened each worker's chance of obtaining coal this winter, it seems likely that there would be some personal interest in speeding up manufacture.

At the same time, of course, a visit to the factory by a miner to explain to the workpeople how his efforts can be helped by prompt delivery of equipment required for opening up new coal seams, or extending existing workings, would increase the effect of any information provided by the works management.

Unfortunately, some executives appear much more afraid of the workpeople's initiative than they are of losing the war, and frequently they offer determined opposition to any scheme which encourages their workpeople to be anything more than Robots.

An example of this attitude was given at a recent conference in Manchester on production, convened by the Association of Scientific Workers, where a speaker instanced the refusal of his management to allow a message of greeting from the workers to be included with some apparatus manufactured for the U.S.S.R.

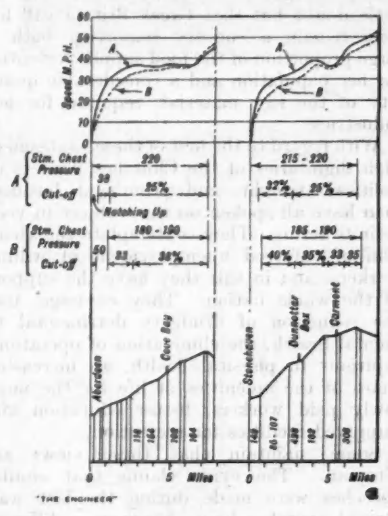
All those seriously concerned with production will welcome your article, and will be encouraged by your examples of what has already been accomplished to tackle that "much more" which still remains to be done.

J. F. AMOR.

Flixton, Manchester, October 2nd.

DRIVING ON THE THROTTLE

SIR,—I have been interested to read Mr. Livesay's account of his experiences on the eastbound "Dominion" express of the C.P.R., in which he raises once again the much-debated subject of engine-driving methods. He writes: "Whether an engine is 'driven on the throttle or the valves' seems very largely a matter of individual preference on the part of the driver—the results appear to be much the same." The privileged observer in the cab is quite likely to see variations of driving method on different locomotives of the same class, and may well tend to form the impression that one way is as good as the other. In all probability, however, the variations are far more due to the respective condition of the engines, to minor variations of valve setting, or to a wrongly calibrated cut-off scale than to the preference of individual drivers.



Whether the same engine, on any one day, would respond equally well to either treatment is another matter. In this connection an experience of mine on the L.N.E.R. 2-8-2 locomotive "No. 2002," "Earl Marischal," showed that driving method can make a good deal of difference. Some years ago I was privileged to make a number of journeys on this locomotive, and twice in one particular day I rode south from Aberdeen on the 10.20 a.m. and 7.35 p.m. expresses. Morning and evening were alike calm and fine, and the loads, 515 and 530 tons behind the tender, sufficiently alike to enable a close comparison of the running to be made. The accompanying diagram shows our progress on the severe inclines leading from Aberdeen and Stonehaven stations. On the morning train "A," with the 515-ton load, the driver used full regulator after the first 50 yards, while on "B" train the regulator was never more than about three-fifths open, giving the lower steam chest pressures noted on the diagram. The "full-regulator" man beat his colleague handsomely from each start, while it will be seen that to equal the "A" speed past Cove Bay the "B" driver had to use 38 per cent. cut-off against 25 per cent. It goes without saying that the blast was heavier with the longer cut-off, and this would tend to cause a higher coal consumption.

O. S. NOCK.

Chippenham, Wilts, October 1st.

FLANGE LUBRICATION

SIR,—In your issue of September 25th Mr E. H. Livesay, in his article on "Canadian Locomotive Experiences," says that flange lubricators are fitted on the "No. 2850" class, then further states that this procedure is by no means new, but at least sixty years old.

It is with interest that I give the following extract regarding flange lubrication, which proves that in 1856, eighty-six years ago, the problem of increased friction on curves was tackled by this method in the United States of America:—

"When the road was first opened, it speedily appeared that the difference of 43ft. on the western side and 58ft. on the eastern side between the gradients on curves of 300ft. radii and those on straight lines was not sufficient to compensate for the increased friction due to such curvature. The velocity with a constant supply of steam was promptly retarded on passing from a straight line to a curve and promptly accelerated again on passing from the curve to the straight line. But after a little experience in the working of the road, it was found advisable to supply a small amount of grease to the flange of the engine by means of a sponge, saturated with oil, which, when needed, is kept in contact with the wheel by a spring. Since the use of the oil was introduced, the difficulty of turning the curves has been so far diminished, that it is no longer possible to determine whether gradients of $237^{6}/_{10}$ft. per mile on curves of 300ft. radius or gradients of 296ft. per mile on straight lines are traversed most rapidly by the engine."

This information was recorded by Mr. Charles Ellet, chief engineer of the Virginia Central Railroad, in a description published in 1856 on the working of a temporary track across the Blue Ridge at Rock Fish Gap.

The full extract was found on page 49 in "Baldwin's Locomotive Works: Illustrated Catalogue of Narrow-gauge Locomotives," published by Messrs. Burnham Williams and Co., Philadelphia, Pa., U.S.A., in 1900.

D. S. KNOTT.

Welling, Kent, October 1st.

HIGH-SPEED STEEL

SIR,—Referring to the letter from Dr. Barclay which appeared in your issue of September 25th, I am surprised to hear that he has found high-speed tools giving readings but little higher than Rockwell "C" 50.

Dr. Barclay's letter caused me to have some

investigation at these works, where we turn out large quantities of tools tipped with high-speed steel. We have no trace over the past ten years of any tool having been found faulty on account of undue softness. In order to check up our current practice, we selected at random eight tools which had already been tipped, hardened, and tempered. These with 30-kilos. load showed hardnesses of between 890 and 912 diamond pyramidal numeral (Vickers' system), which are equivalent approximately to Rockwell "C" 67.

At the present time, on account of the need for great economy in the use of high-speed steel, a certain number of tools are being made from reclaimed material, and some variations in hardness are therefore quite likely to occur. We cannot, however, agree with Dr. Barclay that "C" 64 represents the minimum permissible hardness. In our experience, tools with a hardness as low as "C" 60 give quite good results, and for some purposes this lower degree of hardness is preferable.

ALFRED HERBERT.

Coventry, October 2nd.

Sixty Years Ago

The Tower Bridge

THERE was urgent need sixty years and more ago for effecting improvement in the means of cross-river communication in the London area. Opinion gradually became practically unanimous that the most desirable site for a new bridge would be in the neighbourhood of the Tower, below the lowest of the bridges then spanning the Thames, namely, London Bridge. Unanimity was, however, very far from being expressed regarding the type of bridge to be erected. Many people contended that it would not be advantageous in the long run to provide improved cross-river communication if it could only be given by cutting off a number of the wharves and warehouses immediately below London Bridge from direct access to the sea. Hence one plan that was advanced was to construct a high-level bridge which would enable ocean-going steamers to pass beneath it at most states of the tide. This plan was opposed by others, who argued that it involved the construction of long and expensive inclined approach roads. Others favoured a low-level bridge with sufficient clearance to permit vessels of about 1000 tons cargo capacity to pass up river. In our issue of October 13th, 1882, we gave our approval to this plan in the course of a review of three reports on the subject recently presented by Sir Joseph Bazalgette, Colonel Haywood, and Mr. Horace Jones. Much of the traffic for the wharves and warehouses immediately below London Bridge could, we said, be conveniently handled by barges, while as an alternative communication with the river below the new bridge might be provided by means of lines of rails laid in a subway along the shore of the river. The owners of the wharves and warehouses cut off by the new bridge would have to be compensated, but we proposed that between the two bridges a quay or embankment should be built and that on it there should be erected "a splendid group of warehouses fitted up with every modern convenience," the rent from which would bring in an enormous sum. A few people believed in the desirability of constructing a swing, draw, or bascule bridge, but we stigmatised such a plan as an unsatisfactory compromise between the high and the low-level bridge proposals. . . . Nevertheless, within the next ten years or so the bascule type of bridge was finally selected, a high-level footbridge, reached by hoists, being incorporated in the design in order that passengers might cross when the bascule leaves were raised.

FINLAND SHORT OF LUBRICANTS.—The Finnish Council of State will spend a substantial sum on experiments for the manufacture of lubricating oils from peat.

Electrical Engineers and the Post-War Period*

By PROFESSOR C. L. FORTESCUE, M.A.

No. I.

DURING the presidency of Mr. J. R. Beard—and largely owing to his initiative—a Post-War Planning Committee was formed and is doing valuable work, of which the Institution is likely to hear more during the session. But although such a Committee may advise on policy and elucidate particular problems, it is, nevertheless, the individual members of the Institution who will have to carry the heavy responsibilities which will almost certainly fall to engineers after the war.

The most urgent questions are hardly likely to be those of the restoration of the conditions prevailing in 1939 or of merely avoiding the mistakes of 1919. In fact, to be 1919-minded after this war may be as dangerous as to be 1914-minded now. A new outlook is called for, one capable of a great forward policy and of building an improved industrial system and a better social organisation out of the artificial conditions inevitable in total war. A long view is necessary, for it is not only the immediate post-war years that should be considered, but rather, it is to be hoped, a period of several generations.

Two aspects of the political and economic conditions likely to prevail in this country after the war stand out sufficiently clearly for deductions having some degree of probability to be drawn. First, there is an evident intention that a great effort shall be made to improve the living and working conditions of the less highly paid members of the community. Secondly, there can be little doubt but that Great Britain will for long remain a country importing both a large proportion of the food supplies essential for her population and a considerable quantity of the raw materials required for her industries.

With regard to the first of these, statesmen, high dignitaries of the Churches, leaders of political thought, and prominent business men have all spoken on this subject in very definite terms. They contemplate the abolition of enforced unemployment of willing workers, and in this they have the support of the whole nation. They envisage, too, the reduction of drudgery detrimental to mental health, the elimination of operations injurious to physical health, an increasing share of the amenities of life for the more lowly paid workers, better education and improved facilities for recreation.

Some maintain that these views are Utopian. The cynic claims that similar speeches were made during the last war. Recent speeches have, however, a different tone, in that they forecast a continued effort for the maintenance of civilized conditions throughout the world rather than a return to an easy life with all the advantages and none of the disadvantages of the pre-war *régime*. This latter was the characteristic theme of 1918, and it may be that our aims being now more worthy of perpetuation are the more likely to be realised.

It is one of the disasters of modern times that unemployment and its allied problems should have become a major political issue. The extravagant claims of contending interests irritate—even infuriate—those who are endeavouring to find a solution of the problem by a careful and thorough analysis of all the relevant factors. The Prime Minister himself, speaking of the discordance between consuming and producing power, suggested twelve years ago that this problem should be examined dispassionately by a body having no political or commercial ties. Most engineers will agree that this is necessary. Unemployment is indeed a difficult problem, but surely it cannot be beyond the wit of a civilised community to devise a plan which, whilst retaining the incentive to bold action resulting from great reward for success, avoids the mental, moral, and physical deterioration that inevitably results from many members of the community being wholly unemployed and many others being engaged upon work which brings them neither satisfaction nor pride in its accomplishment. I suggest to the members of this Institution that the steps to be taken to avoid unemployment will constitute the corner stone of all post-war replanning.

The share of engineers in the avoidance of unemployment is likely to be limited. They can, it is true, exert an influence in the direction of lifting the problem from the political arena. But until that is accomplished they can do little more than hold a watching brief and prepare themselves to adapt their methods to new conditions as they arise. Given a free hand, there is much that engineers could do, both to avoid unemployment and to bring about social improvement, but they know full well that these can only be accomplished if the country is prepared to accept a discipline resembling that imposed by war, and an organisation of its activities such that it can pay for the commodities and the services it requires from other countries. That is to say, they know that these ideals cannot be realised without hard work and unselfish co-operation and unless our external trading account can be balanced.

* * * *

The difficulty of increasing exports lies in finding markets without our being compelled unduly to reduce prices, *i.e.*, being compelled to accept so little in exchange for our products that our internal standards of living are reduced in spite of our avowed intention of improving them. A reduction of our home consumption of exportable products is perhaps more feasible, but it may not prevent prices from falling unduly. The banning of imported luxuries may be necessary and by the increased use of materials produced at home some reduction in our consumption of imported raw materials might be effected. But it seems unlikely that either can be on a large scale. Also, since there are now far more taxpayers than agricultural workers, it seems a fair presumption that it will only be when other expedients have failed that financial inducements will be offered to agriculture sufficiently great to bring about a yet further increase of home-grown food. Each possibility may make some contribution, but the unavoidable conclusion is that the real answer to the problem is only to be found in the skill, vigour, and initiative of all engaged in industry, and in their ability to produce commodities of so

* Excerpts from the Presidential Address to the Institution of Electrical Engineers, October 1st.

high a quality and so suitable for their purpose that they are eagerly sought for by the rest of the world. The higher the standard of living that can be maintained throughout the country by good internal organisation, the more likely it is that goods of this high utility will be produced. In order to avoid unemployment and to improve working conditions it may be desirable to adopt refinements of method which in the past have not been justified owing to the additional man-hours required. The cost of these man-hours is an internal matter, and may have to be shared by the whole community in order to secure necessary imports. It may not be a matter of manufacturing in this country at a price (measured by internal currency) low enough to enable us to sell abroad, but rather of producing, by any means within our power, goods that will be in demand elsewhere. Should this be the case, it is hardly likely to relieve the engineer of his traditional *rôle* of "doing for eighteen pence what others can do for half a crown." Rather will it accentuate his responsibility in this respect, though the measure of his success may not be made directly in terms of coins of the realm.

* * * *

One of the first of the problems with which electrical engineers may be called upon to cope in the post-war period—and one with which we are very intimately concerned at the present time—is the conservation of coal. Coal is an exportable commodity and one of which we have exported larger quantities in the past than in recent years. It is an essential for all our home industries, and the basis of many of them. We have large quantities of it—some of very high quality. But the conditions under which the miners work underground are onerous and often dangerous. Humanitarian considerations therefore favour any possible reduction in the amount raised. So, on the one hand, we are likely to want more coal available for export, and perhaps for industry as well, and, on the other hand, we are likely to wish to see a decrease in the number of miners working underground, those so released being found employment elsewhere. The only way in which these two ends can be realised simultaneously is by greater efficiency in the use of coal.

Between 1927 and 1933 two great electrical schemes were fully investigated by expert committees acting under Government auspices. Lord Weir's Committee reported in 1931 on Main Line Electrification, and a Committee sitting under Colonel Moore-Brabazon (now Lord Brabazon) reported in 1933 on the Severn barrage scheme. Both reports were in favour of proceeding, and each scheme would have led to a saving of coal.

Lord Weir's Committee favoured the electrification of the whole of our railway system and, irrespective of other advantages, such as increased traffic facilities, greater cleanliness, and improved conditions for the personnel operating the trains, this plan would save between 9 and 10 million tons of coal per annum. This coal would be available for export or, if not required for export, 25,000 to 30,000 miners could be released from work underground and would be available for productive work elsewhere. Lord Weir's Committee drew attention to the probability of an electrified system being more vulnerable to enemy action. We have now had experience of this, and although the facts are not generally available, I suggest that the engineers of our railway companies should examine the situation fully. So far as the information given in published reports goes, there is no evidence that the electrified portions of our systems suffered more seriously than the others. To the best of my knowledge there have been no reports of our having made special efforts to attack the electrified parts of the railways of Germany. Is it not possible that the great emergency overload capacity of an electrified system more than compensates for the increased vulnerability? If so, the "most serious aspect" of the proposal—as Lord Weir's Committee calls it—is non-existent, and there can be little reason for our not proceeding with the complete scheme after the war. It was expected to occupy some 60,000 men for a period of twenty years. Most of this work is high-grade or skilled labour, and it would thus be a great contribution not only to the alleviation of unemployment, but to the employment of our people on work of a high standard.

(To be continued)

Automatic Welding in Shipyards

IN our issue of June 5th we recorded the appointment of Mr. R. B. Shepheard, B.Sc., one of the senior ship surveyors of Lloyd's Register of Shipping, to the staff of Sir Amos Ayre, Director of Merchant Shipbuilding and Repairs at the Admiralty, in order to give assistance to welding in British shipyards. We also announced that Mr. Shepheard would give special attention to the introduction into British shipyards of a new type of automatic welding machine, working on the submerged arc principle, which has been most successfully employed in American shipbuilding and repairing yards. A supply of these special machines has been obtained from America in collaboration with the British Oxygen Company, Ltd., which firm represents the Unionmelt interests in this country. The necessary auxiliary electrical apparatus is being made in England and Scotland by electrical firms of repute, and already several sets of machines are at work in British yards.

FIG. 1—COMPLETE SHIPYARD WELDING PLANT

By permission of the Admiralty, we recently visited one of the works of the British Oxygen Company, Ltd., and saw some of these welding equipments ready for despatch. Some account of their principle of operation and the design of the machine and electrical equipment will be of interest to our readers.

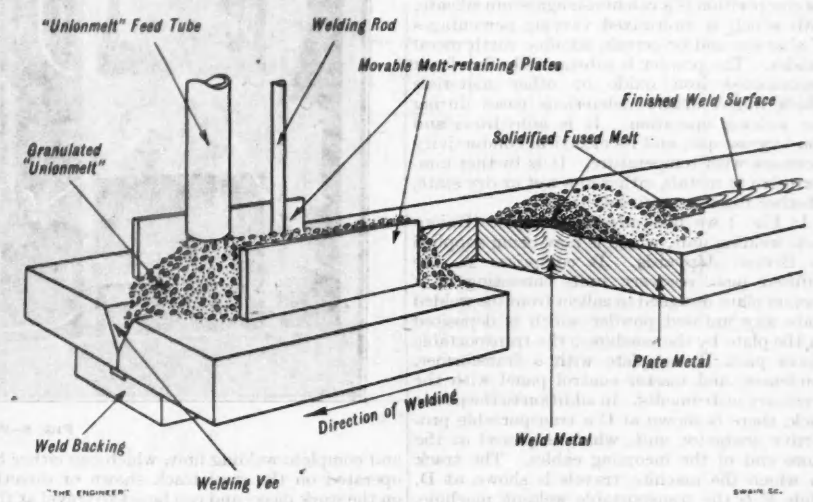


FIG. 2—DIAGRAM OF WELDING OPERATION

The Unionmelt system provides a process of

electric welding in which molten metal from a metal electrode is deposited on the parent metal beneath a blanket of unbonded finely divided material, which is electrically conductive when in a molten state. The material is known as "Unionmelt," or more commonly as "melt." In the system the electrode is a bare rod, which is fed at a determined rate, which is automatically controlled by the machine to coincide with the rate at which it melts, and the necessity of keeping a constant gap between the end of the rod and the parent plate through the granulated material. The melt offers a certain resistance to the flow of current through the rod to the plate and heat is generated. The heat thus generated by the current stream is confined to a relatively small zone, with a temperature estimated at between 2000 deg. and 2500 deg. Cent., but the wash effect of the superheated metal increases the area of the weld puddle. The end of the rod is quite close to the leading edge of the puddle, and the molten metal is carried backward from the rod to the top of the plate at an angle of less than 30 deg. During the welding process the fluid metal is thoroughly cleansed of all impurities and occluded gases, which if not present in too great a quantity, escape through the layer of molten melt above the metal. The fundamental nature of the process is that of resistance welding, the resisting material being the Unionmelt powder. The diagram reproduced in Fig. 2 clearly shows the process and the resulting flat bead.

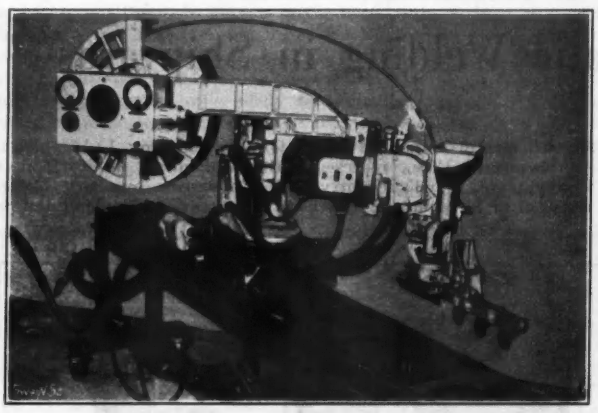
It may be stated that the Unionmelt powder is an artifically formed electric furnace product. Its composition is a calcium-magnesium silicate, with which is intermixed varying percentages of alumina and/or certain alkaline earth metal halides. The powder is substantially free from uncombined iron oxide or other materials which might evolve deleterious gases during the welding operation. It is anhydrous and non-hygroscopic, and its electrical conductivity increases with temperature. It is further non-corrosive to metals, either in a wet or dry state, whether fused or unfused.

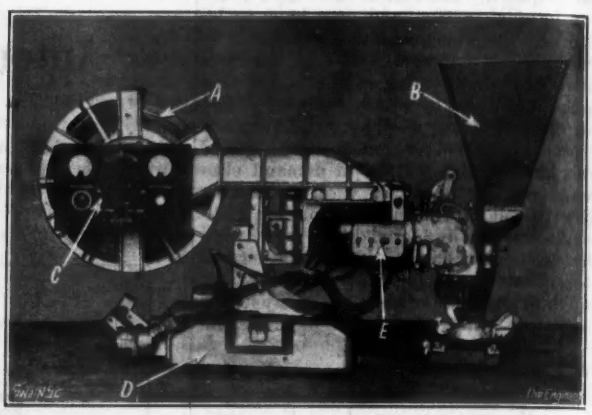
In Fig. 1 we illustrate the complete Unionmelt welding unit, which is now being supplied to British shipyards. It comprises A, the unfused melt recovery unit, consisting of a suction plant designed to collect from the welded plate any unfused powder which is deposited on the plate by the machine; the transportable power pack B, complete with a transformer, condenser, and master control panel with the necessary instruments. In addition to the power pack, there is shown at C a transportable protective contactor unit, which is placed at the shore end of the incoming cables. The track on which the machine travels is shown at D, while E is the transportable welding machine, and F the control and welding cables.

A general view of the welding unit is reproduced in Fig. 3, which shows the machine mounted on a section of the track on which it travels. The head is designed so that it can be set at any angle. It is suitable for making fillet welds at 45 deg., as well as straight butt welds.

The machine is designed to pull bare welding rod from $\frac{1}{16}$in. to $\frac{5}{16}$in. diameter from a coil, and straighten it, introduce the welding current, and feed the rod into the welding zone. Besides providing for feeding the rod in various directions in relation to the supporting bracket, there is a mechanism, shown hinged on the front of the machine in Fig. 3, for guiding the rod by means of three bevelled guide wheels into the desired position along the seam being welded, and at the same time for progressively depositing the blanket of Unionmelt powder ahead of the welding zone. The rod-feeding mechanism comprises a series of knurled feed rolls, which are rotated by a motor through reduction gearing. This action pulls the rod through the straightening rolls, and forces it through contact jaws, attached to the special current conductor attachment. The machine is built to handle currents up to about 2000 amperes. From our illustrations it will be seen that the special attachment of the rod reel to the welding head, and the assembly to the travelling carriage, is such as to make a light, portable, and complete welding unit, which can either be operated on the steel track shown or directly on the work piece, and can be set to travel at the appropriate speed for welding, from 4in. to 80in. per minute. The carriage itself is strongly designed and is driven from a built-in electric motor, operated and controlled by the easily accessible switches and speed controls, which, as shown in Fig. 4, are an integral part of the housing. In Fig. 4 the wire rod reel is seen at A, the hopper for the Unionmelt powder at B, and the welding control panel at C. D is the carriage and E the control switch-box.

The instruments on the switch-box and the control panel consist of a pilot warning light, a speed indicator, and a speed setting control, while other equipment comprises a voltmeter and an ammeter, a voltage control wheel, and remote control buttons for varying the output from the main transformer. At the base of the welding head there are arranged the starting switch for the carriage, a relay switch for operating the main contactor, a rod-reversing switch, and a rod-inching button. For starting the weld a small ball of steel wool is placed below the end of the welding rod and the rod is then advanced to compress it slightly. When the rod is covered with powder by operating the valve lever on the hopper, thus filling the space between the guide plates, the current is switched on and welding begins. As the welding heat is conserved by the blanket of powder, there is little to see, and the welding progresses silently and unobtrusively. After the seam has been finished the current is switched off, and the unfused Unionmelt powder recovered by using the unfused melt recovery unit shown to the extreme left of Fig. 1. This unit consists of a motor and fan placed on the top of a cyclone, which is provided with a filter and a screen, below which is the hopper in which the unfused melt powder is collected, by means of a suction nozzle with a twin-ended fish-tailed orifice, which draws the powder from either side of the finished weld. The fused melt cracks loosen of their own accord





FIGS. 3 AND 4—THE WELDING UNIT

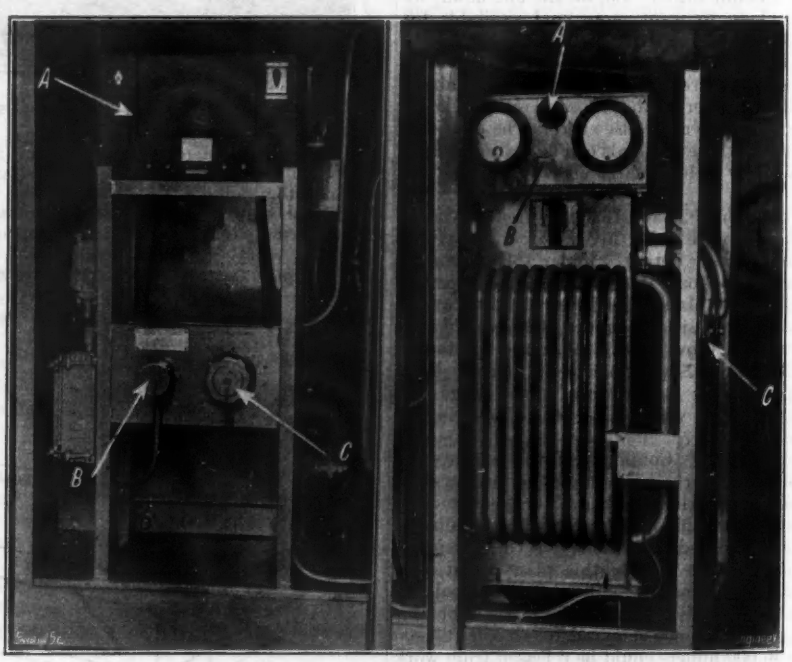


FIG. 5—POWER PACK

during cooling, leaving the flat broad welding bead with no undercut to its edges.

The rod reel is designed to carry about 25 lb. of wire coil, having an inside coil diameter of 12in. The reel does not rotate, but the coil itself turns within an annular space bounded by rotating rollers.

For supplying power to the machine, which employs single-phase 400–440-volt A.C. current

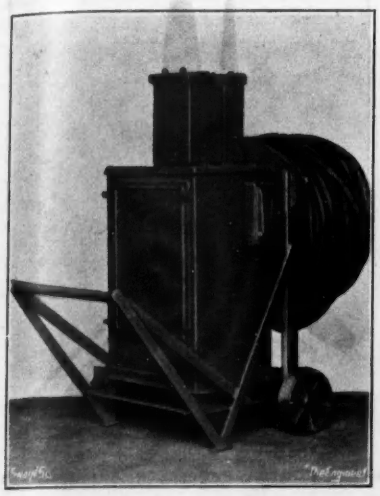


FIG. 6—PROTECTIVE CONTACTOR UNIT

a transportable power pack, illustrated in Fig. 5, is provided. It is mounted on a steel base, having a sheet steel roof with canvas sides, which can be let down to protect the apparatus from inclement weather. It is furnished with a lifting eye, so that it can be transported by the crane and positioned on the ship or on the assembly skids to suit the welding site. The unit, which has a height of about 6ft., a length of 8ft., and a width of about 4ft., weighs about 2¼ tons.

It consists of a 1000-ampere nominal 440–100-volt, 50 cycle, single-phase, oil-cooled special welding transformer, having a built-in remote control reactor, which enables the output on the secondary winding to be varied between 250 and 1250 amperes. The secondary winding is provided with a tap to give a secondary voltage of 85 volts, if required. The pack is set to the 100 volts tap at the works of the British Oxygen Company before despatch to the shipyard.

For power factor correction, a 65 kVA condenser, consisting of two 32·5-kVA condenser assemblies in a single tank, is provided, so designed that it is capable of being connected in circuit by an external manually operated switch. There is a master control panel for the welding machine, and, in addition, a "through" type 5-VA ammeter current transformer, having a ratio of 2500 : 5. Plug connections for the pack include those for the primary cable, the control circuits for the welding machine, and the unfused melt recovery unit previously described. In Fig. 5 to the right, A is the local control for adjusting the output of the transformer, B an indicator dial giving an indication of the transformer setting, and C shows the power connections, one of which goes to the welding machine and the other to the earthing plate on the work. The control stand of the unit is shown to the left of Fig. 5. In this view A is the master control panel, from which the current supplied to the welding machine is regulated, B is the plug outlet for the unfused melt recovery unit, and C is a 25-point multiple pin plug for the welder control cables.

In front of the complete assembly, seen in Fig. 1, are the coils of the connecting cables. They comprise 120ft. of primary cable and two secondary welding cables for each side of the circuit, each 100ft. in length, along with control cables of equal length. By this arrangement, the welding unit can be employed within a radius of 220ft. from the point of supply. Thus the power pack can be placed on the deck of a ship and the welding machine set to weld the deck seams and butts.

The transportable protective contactor unit, illustrated in Fig. 6 and already mentioned, is arranged at the shore end of the incoming power cables to the main power pack. It consists of a 200-ampere double-pole contactor circuit breaker, which is also fitted with overload protection. Other equipment includes a 440–100-volt, 2-kVA transformer and a 5-ampere H.R.C. switch fuse. The contactor is closed by means of a relay, the operating coil of which is energised from the built-in 2-kVA transformer, the secondary voltage of which is 110 volts. The operating switch for the contactor closing circuit is situated on the welding machine, so that the contactor will remain in the closed position only when the operating switch on the welder is closed. When closed, a circulating current of approximately 0·5 ampere at a pressure of 110 volts flows through the circuit, comprised by the conductor closing relay, the machine operating switch, and a pilot conductor and a screen on the incoming primary power cables to the power pack. The arrangement ensures that any damage which may be caused to the incoming cables, such as might break the screen and pilot circuits, will interrupt the 440-volt supply and cause the protective contactor to trip, thereby immediately isolating the power pack from the 440-volt supply main. The arrangement serves to prevent the ship's plates from being charged to any dangerous potential above earth, should damage occur to the incoming cable. Suitable cable-connecting plugs are provided and the complete wiring is given in the accompanying wiring diagram. The unit, as our illustration shows, is mounted on a wheeled carriage in order to facilitate movement on the slipway, and is enclosed in a drip-proof case. It weighs about 400 lb. and is 5ft. high.

The power requirements vary according to the thickness of plate to be welded. The maximum requirement per machine is about 60 kVA at 440 volts, but the majority of the welds call for about 40 kVA. In case of more than one machine being required, it is possible to arrange machines across each of the three phases in the system, thereby achieving a better balance. In actual practice, special welding sheds can be designed having a separate source of supply, as it is unadvisable to use welding machines on circuits which may be subject to fluctuating loads caused by other shipyard machinery. In Fig. 7 we show the wiring diagram for a Unionmelt plant installed in a shipyard.

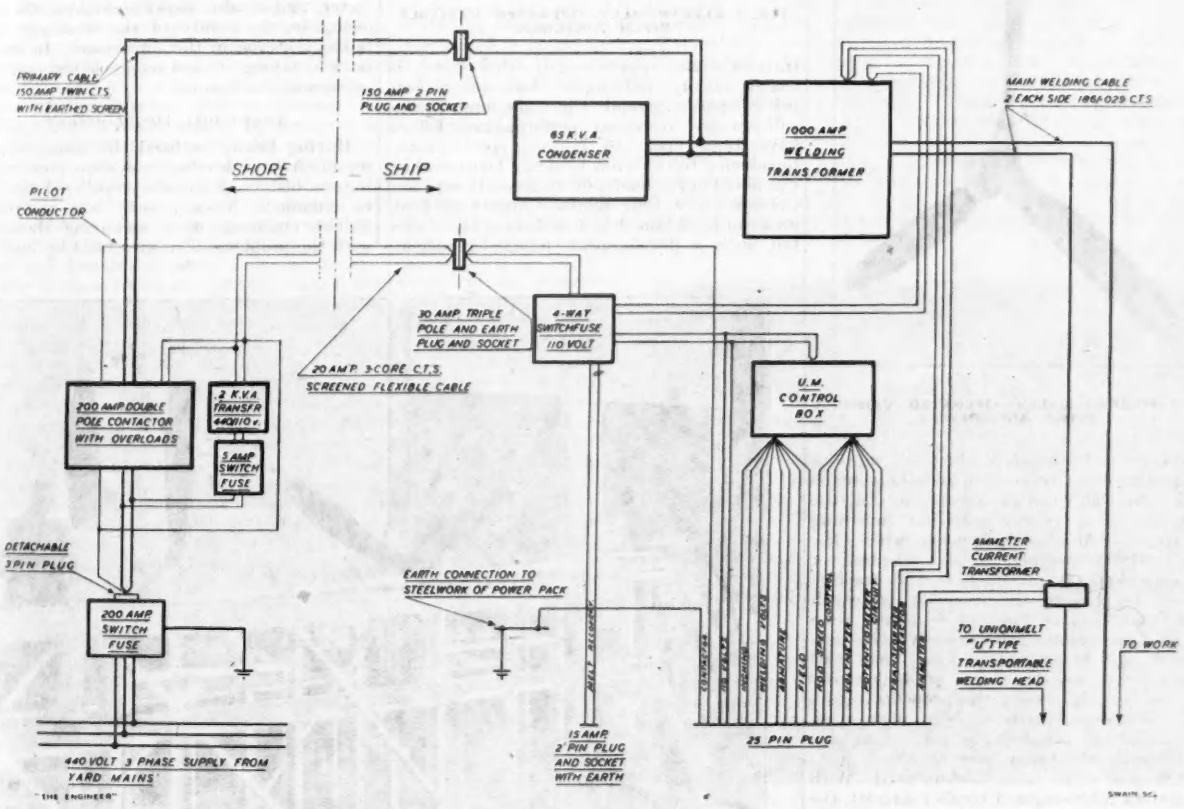

PRIMARY CABLE 150 AMP TWIN C.T.S. WITH EARTHED SCREEN
150 AMP 2 PIN PLUG AND SOCKET
65 K.V.A CONDENSER
1000 AMP WELDING TRANSFORMER
MAIN WELDING CABLE 2 EACH SIDE 1/0/0-029 C.T.S.
SHORE
SHIP
PILOT CONDUCTOR
30 AMP TRIPLE POLE AND EARTH PLUG AND SOCKET
4-WAY SWITCHFUSE 110 VOLT
20 AMP 3-CORE C.T.S. SCREENED FLEXIBLE CABLE
U.M. CONTROL BOX
200 AMP DOUBLE POLE CONTACTOR WITH OVERLOADS
2 K.V.A TRANSFR 440/110 v.
5 AMP SWITCH FUSE
DETACHABLE 3 PIN PLUG
200 AMP SWITCH FUSE
EARTH CONNECTION TO STEELWORK OF POWER PACK
AMMETER CURRENT TRANSFORMER
TO UNIONMELT "U" TYPE TRANSPORTABLE WELDING HEAD
TO WORK
15 AMP 2 PIN PLUG AND SOCKET WITH EARTH
25 PIN PLUG
440 VOLT 3 PHASE SUPPLY FROM YARD MAINS
"THE ENGINEER"

FIG. 7—WIRING DIAGRAM FOR WELDING PLANT IN SHIPYARD

We understand that many of the machines we have described are already doing excellens work in various British shipyards, and that in some yards extended use of the Unionmelt automatic welding machine will be made. We

are indebted for the illustrations and drawings used in this article to the British Oxygen Company, Ltd., and to Mr. A. P. Chalkley, the Editor of *The Motor Ship*, for certain special photographs which were specially taken to illustrate our article on these machines, which appear in the current issue of our esteemed contemporary.

British Airscrew Development

WHEN describing new fighter and bomber aircraft, we have frequently had occasion to refer briefly to the modern types of British airscrews which are being fitted to these machines. With the object of seeing something more of this important side of aircraft production engineering, we recently accepted an invitation by the Ministry of Aircraft Production to visit one of the works of Rotol Airscrews, Ltd. In that works we saw modern propeller production with wood and metal airscrew blades and the important advance which has been made in recent years in the transition from the first fixed-pitch two-bladed airscrew to the four-bladed propeller, and following the introduction of the supercharged engine to the two-position variable-pitch propeller which was in production before the war. Later designs have included the constant-speed variable-pitch airscrew, in which the blades, on beginning to revolve, are automatically set at an angle which affords the greatest tractive effort for a given engine speed. The blade angle is further automatically increased or decreased in order to

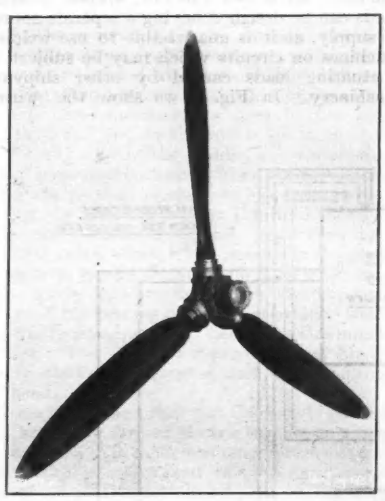


FIG. 1—HYDRAULICALLY OPERATED VARIABLE PITCH AIRSCREW

afford more or less tractive effort as conditions may demand, so as to maintain a constant engine speed. In the constant-speed propeller the airscrew itself provides a means of governing the engine. Another refinement which has been rendered possible by the adoption of the variable-pitch propeller is the feathering of the blades, the necessity of which arises from the fact that engine failure from any cause may result in the airscrew acting as a windmill, and under certain flying conditions cause it to rotate the engine at dangerously high speeds. By setting the propeller blades in the feathering position, their angle is so altered that the possibility of further damage to an engine, which may have already stopped through some other cause, is eliminated. With the modern multi-engined bomber aircraft, the provision of a feathering airscrew not only prevents engine damage, but it also reduces wind resistance, which would be caused by the airscrews windmilling, thereby increasing the speed of the aircraft and possibly enabling it to make its base safely on its remaining engine or engines. We are informed that many cases have occurred where the provision of feathering airscrews has made all the difference between the loss of an aircraft and its crew or the safe return of the machine.

Recent propeller research has confirmed that the maximum efficiency of a propeller working in air is attained when the tips of its blades are

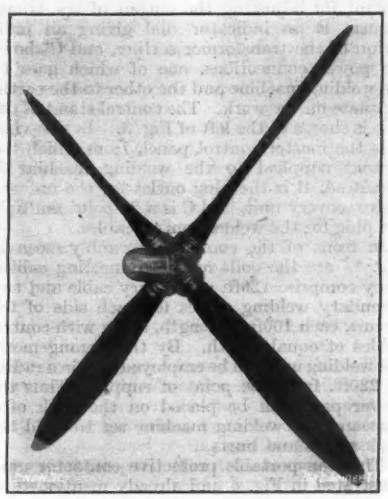


FIG. 2—ELECTRICALLY OPERATED VARIABLE PITCH AIRSCREW

travelling at approximately the speed of sound, namely, 750 m.p.h. Increase of propeller speed beyond the maximum range will not give increased performance. Efforts have been made to improve performance, broadening the airscrew blades, a feature which was noted in the blades of the recently captured German "F.W.190" fighter. Additional blade area can be obtained by lengthening the blades, but such a development tends to increase the size of the landing gear to fit in with the longer propeller blades, which would detract from the stability of the aircraft and increase its weight and cost. A possible solution is afforded by the adoption of an increased number of blades. Examples of three and four-bladed airscrews are illustrated in the accompanying engravings. A recent development on which we have already commented in our issues of September 5th and 26th, 1941, is the "contra-rotating propeller" in which two sets of

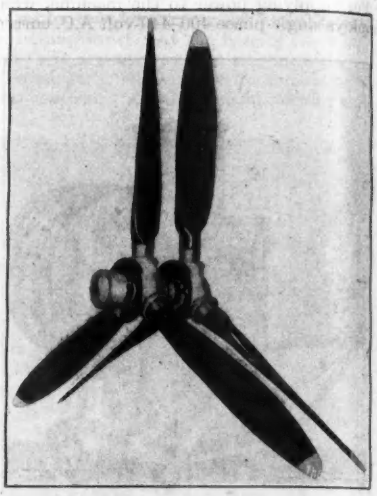


FIG. 3—CONTRA-PROPELLER ARRANGEMENT

blades revolve in opposite directions, one behind the other. An example of this construction in its three-bladed form is illustrated herewith. We were able to see this latest type of airscrew under test in the testing hangar and flown in the air on a fighter machine by Mr. L. B. Greensted, the chief test pilot of the firm. The results show that a contra-propeller having two sets of three blades has about double the pulling power of a single three-blade propeller of the same diameter, and it also shows improved efficiency, owing to the ability of the arrangement to nullify rotation in the slipstream. In the air, both in taking off and manœuvring, improved performance is claimed.

Historical Development

Having briefly outlined the steps taken in recent airscrew development, some facts regarding the history of British propeller design may be recorded. Twenty years ago a group of British engineers were occupying themselves with the problems then presented by increased engine and aeroplane speeds, which showed that the fixed-pitch type of propeller then in use would not deal efficiently with the variations presented by take-off and maximum speed at high altitudes. They therefore set about

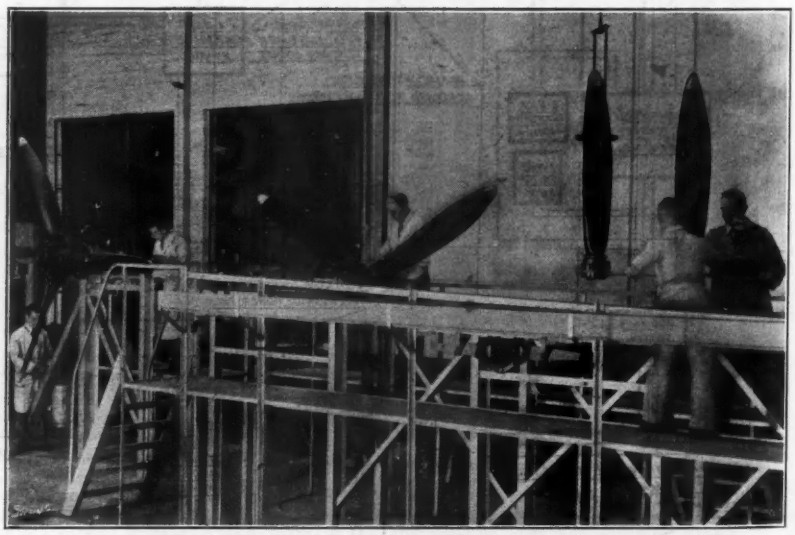


FIG. 4—ERECTING PLATFORM FOR AIRSCREWS

designing a propeller, the blades of which could be turned and the pitch thereby varied in flight. In 1924 a provisional patent for the Hele-Shaw-Beacham variable-pitch propeller was lodged. The following year the first airscrew of the Hele-Shaw-Beacham variable-pitch type was built and fitted to a Rolls-Royce "Condor" engine. The blades were made of hollow steel, and the hydraulic mechanism for controlling their position was of the internal

FIG. 5—ASSEMBLY PLATFORM FOR AIRSCREWS

cylinder pattern, generally similar in type to that used in the modern Rotol propeller which is now employed on the "Master", I and II trainer aircraft. The tests made by the Air Ministry with this first variable-speed propeller were satisfactory and a contract for twelve airscrews was awarded. By arrangement with the inventors, this work was carried out at the works of the Gloster Aircraft Company, and the propellers were made for Rolls-Royce "Kestrel" and Bristol "Jupiter" engines. A considerable number of flying hours were put in on "Grebe" and "Gamecock" aircraft fitted with Bristol "Jupiter" engines. It is of interest to record that this propeller was fitted with a hydraulically operated external cylinder mechanism controlled by a constant-speed unit, exactly in the same manner as the latest Rotol propeller, which is fitted to the modern "Hurricane" and "Spitfire" fighter machines.

The firm of Rotol Airscrews, Ltd., was started in May, 1937, with the object of combining the knowledge and experience which had then been acquired by Rolls-Royce, Ltd., and the Bristol Aeroplane Company, Ltd., each of which firms had independently carried out research work on the development of a variable-pitch propeller of all-British design. The manufacturing rights for the Hele-Shaw-Beacham invention were acquired by the company, and that propeller finally emerged as the Rotol variable-pitch propeller. A good deal of development work was carried out between 1937 and 1938, when the new Rotol factory was erected and production begun shortly afterwards. In the first year the internal cylinder type of variable-pitch propeller was produced and was used by the Royal Air Force on the Vickers-Wellesley aircraft that made the world record-breaking flight from Egypt to Port Darwin in Australia in 1938. That propeller, the performance of which was far in advance of the earlier fixed-pitch type, had only a limited pitch range of 20 deg., but with the increasing demand for improved performance a greater pitch range was found to be desirable for all types of aircraft. The Rotol external cylinder propeller illustrated now has a 35 deg. pitch range when fitted to single-seater fighter machines, and a 65 deg. pitch range for multi-engined heavy bomber aircraft. In recent years many other types of constant-speed propellers with variable pitch, both with hydraulic and with electric operation, have been designed and put into production by the firm with excellent results.

Although the company carried out much of its earlier work with metal propellers made of hollow steel and of light metal alloy, it saw early in the war the possibility of difficulties with metal supplies for the manufacture of airscrew blades, and turned its attention to the use of wooden blades, made on the Rotol "Jablo" system with densified laminated wood, and other types of wooden laminated construction. We noted that all Rotol propellers are now interchangeable, whether they are constructed with wood or metal blades.

WORKSHOP IMPRESSIONS

Our inspection of the works showed the well-planned nature of the factory, which has been laid out to manufacture and assemble not only airscrews but the intricate and delicate mechanism which controls the extremely rapid changes in the pitch of the propeller necessary to maintain constant engine speed. For example, the constant-speed unit, which only weighs 5 lb., consists of 177 parts, all of which are productions of precision finish and accuracy. The same applies to the hydraulic and electric controls within the propeller hub. Our first visit was to the large tool-room, in which the tools and gauges are prepared. In this department we noted jig borers of the Pratt and Whitney and Société Genevoise "Hydroptic" patterns. For the ring gauges used on propeller blade roots and assemblies, thread grinding to 0·0001in. diameter and pitch was seen. In the general machine shops the boring of propeller hubs on Bullard machines was noted, and it was with interest that we observed that half-round shells flash-welded together and made of alloy steel are replacing the former heavy forgings of nickel-chrome steel from which the propeller hubs are machined. For other machining processes the use of high-power broaching machines was noted. In another machine shop plant is installed for the complete machining of the constant-speed unit, and the hydraulic control mechanism for setting the blades to the required angle. The hydraulic pump draws oil from the engine sump and delivers it at a pressure of 500 lb. per square inch. The pump consists of eight main parts, the centre casing forming the pump body, being made from an aluminium die casting. These casings undergo their first operation on an 18in. Archdale milling machine, which removes the top face of the casting for location purposes. The body is afterwards jigged and goes through its various machining operations. For the gears in the gear-box, up-to-date gear grinding and gear lapping are employed, and, after testing, the parts pass to the unit and gear-box assembly shop. Use is made of several mechanised grouped gauges, which greatly facilitates the quick and accurate inspection of the small precision parts. A separate bay is reserved for the automatic machines used for the production of small parts. In the centre of the works there is an overhead inspection platform, from which a view of all departments is obtained. The parts arrive from the shops and gravitate towards the final viewing point, and after passing the tests are taken into the stores and are again passed out through the issue stores to the propeller assembly bays. We reproduce two views taken in the assembly bays, showing the vertical platforms along which the propellers pass in succeeding stages of assembly. Prior to coming into the assembly bay, each propeller is carefully balanced to very fine limits, appropriate balancing shims being added. In assembling the propeller blades, we were informed, the ball-bearing assembly is preloaded so as to impose a stress equal to about half the centrifugal pull of the blade when running at its scheduled speed.

Finally, we were able to inspect in the No. 1 test hangar one of the new contra-propellers of three-bladed construction, similar to that illustrated under test. The test hangars are among the largest of their kind in the country, and we reproduce a view of No. 1 hangar showing a propeller under test with a Bristol "Hercules" engine. The engine chamber is asbestos lined in order to reduce noise, and all the measuring instruments are arranged on an elevated platform at the side of the chamber, from which the engine and propeller under test may be inspected through a glass window. Liquid-cooled engines are catered for by means of a closed cooling system, which includes a 45-gallon tank for water or Glycol under pressure, and a Serck heat exchanger. In the case of air-cooled engines, the cooling of the engine is assisted by means of an axial flow two-stage fan, which is driven by a 215 B.H.P. variable-speed motor.

FIG. 6—ELECTRIC AIRSCREW IN TEST HANGAR

In No. 2 hangar we saw an improved design of testing chamber which has been built as a result of some 2500 hours of testing experience in No. 1 hangar. In this design a cylindrical shroud has been incorporated in order to screen the propeller, the object of this arrangement being to enable the propeller to operate in an atmosphere which is undisturbed by the eddies and currents which are associated with running in an open hangar. The new design, it is claimed, more readily simulates the conditions existing in actual operation. A torque reaction and thrust device is included in the equipment, from which it is hoped to obtain additional technical data with regard to propeller efficiency and performance, while propeller vibrations are also closely studied.

Before leaving the works we were permitted to see the manufacture of metal airscrew blades, which are still employed for some machines and for certain replacements. The shaping of the blade sections on Berliner and Sunstrand machine tools, using a master cam, was seen, and the following operations of grinding and finishing the blades prior to passing through a combined painting and anodising operation. In the works school and instruction centre interesting models of the different patterns of airscrews and propeller blades manufactured by Rotol and its associated companies were exhibited, and several examples of field repairs made to Rotol propellers were on view. In the present article it has been possible only to give a general short account of some of the Rotol activities, but in a later article we hope to deal more fully with one of the later types of constant-speed variable-pitch propellers with electrical operation.

Floatless Liquid Level Control

The accompanying diagram illustrates the "Lectralevel" system of floatless liquid level control, recently developed by Londex, Ltd., of Anerley Road, London, S.E.20. Two electrodes are installed in the tank, into which or from which the liquid is to be pumped. One of these electrodes is long, the other short, and both are connected to a Londex L Q A mercury switch relay, capable of operating the controls of the motor starter of a pump emptying or filling the tank. The circuit between the electrodes and the relay is completed through the liquid itself. One of the electrodes is connected directly to the relay, whilst the other has a small resistance in circuit. Current at 25 volts pressure is obtained from a small double-wound transformer, actuated from the main 230-volt supply. Supposing, in reference to the diagram, the liquid level is sufficiently high to make contact with the shorter electrode, then the relay will be operated and the pump started. Very soon, of course, with a falling liquid level, contact between the liquid and the shorter electrode will be broken, but sufficient current flows through the longer electrode, despite the resistance in series with it, to hold the relay in. When the liquid level falls so far that contact with the longer electrode is broken, the flow of current to the relay is interrupted, and the relay switches off the pump. Now with a rising liquid level the re-establishment of the circuit through the longer electrode does not result in sufficient current flow to throw the necessary switch, and consequently the pump motor is not started until the liquid rises far enough to reach the shorter electrode. The equipment supplied by the firm for this level control does not include the electrodes and electrode holders, which it is more satisfactory the customer should make up to suit his own requirements. Ordinary galvanised wrought iron gas tubing is recommended as suitable for the purpose.

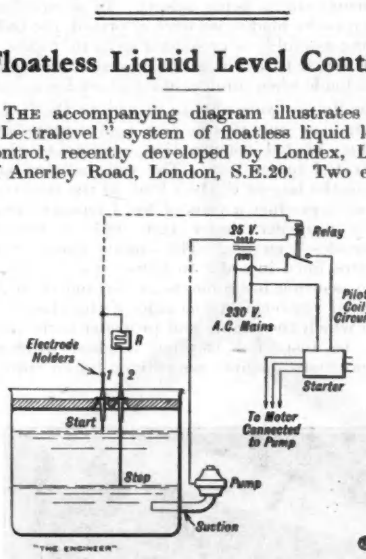


DIAGRAM OF "LECTRALEVEL" CONTROL

Employment of Women in Electricity Undertakings

For the past eighteen months the Electricity Commissioners have urged the electricity undertakers to investigate the possibility of employing female labour on electrical work. Last year notes were issued showing what had been done in that direction in the case of one large generating station in London. More recently, the Electricity Commissioners and the Central Electricity Board have been assisting electricity undertakers in their task of securing additional staff for the carrying out of maintenance and other work at generating stations, and for manning the new generating plant which is due to come into commission before the end of the year. In this work the Commissioners and Board have been brought into very close contact with the headquarters of the Ministry of Labour, and with the various Regional Controllers of the Ministry. As a result of the experience gained, it seems evident, they say, that although the man-power position has been difficult this year, it will be unquestionably much more acute next year. The Electricity Commissioners and the Central Board state that it is their considered view that much greater reliance must be placed on the employment of female labour, particularly in generating stations. Figures which have been made available to the Commissioners indicate that the number of women at present employed for various purposes in electricity undertakings, other than for clerical duties, in canteens, or as nurses, amounts in total to 1532, which are spread among 123 undertakers. Further, approximately 580 of these women are employed in 55 selected stations. There is no doubt, the Commissioners say, that women can be suitably employed for a larger number of duties in the electricity supply industry, and a schedule has been drawn up showing the occupations in which women are now engaged, which should be useful to the electrical undertakers. With a view to enabling the Regional Areas to supply the female labour required, the Commissioners have invited undertakings to inform them as to the probable number of women who can be absorbed into the undertaking before the end of the year, and the nature of the duties for which they are to be trained. Application will have to be made to the local employment exchange for the engagement of female staff for operational and maintenance work, and this work has been put on the short list of vital war work in which women may be placed after interview under the Registration for Employment Order.

Making a Mark.—We have to thank Edward Pryor and Son, Ltd., Broom Street, Sheffield, 10, for a very handsome brochure entitled "Making a Mark." Many engineers who are quite accustomed to using materials and equipment on which words, signs, and figures appear, have never asked themselves how the work which is often beautifully executed is done. In this volume the whole art is described, particularly as regards the production of marking devices like the punches which are commonly found in engineers' workshops, and the roller dies which are used in certain cases. The letterpress is written in a free and readable style, and the illustrations, all taken in the works of Edward Pryor and Son, are, without exception, admirable. The book is not a catalogue, but it is sound propaganda, for it shows the great care taken in the company's works and the high skill required in the production of marking devices.

Big Post-War Plans in South Africa

Some details of the South African Government's post-war plans have been disclosed. Works being held in reserve to provide employment after the war will involve the expenditure of millions of pounds. The Railway Administration alone is likely to embark on a building programme that will cost at least £5,000,000 annually over a period of years. In addition, many thousands of tons of steel rails will be needed to restore the permanent way to its normal high standards of safety and smooth running, while the numbers of locomotives which will be required to replace wastage and to cope with the increasing volume of passenger and goods traffic may be imagined when it is realised that no steam locomotives have been placed in service since 1940 and that even then there were a number on order which have not been delivered owing to the exigencies of war. Hundreds of new locomotives will no doubt be urgently needed when it becomes possible to order and obtain deliveries in reasonable times. As to coaching vehicles, such as drop-sided steel wagons, covered cattle wagons and fruit wagons, bogie wagons, and wagons for special purposes, the number required to-day of all these runs into thousands. In addition, large sums will have to be spent on such undertakings as replacing the numbers of small craft which the Railway Administration has had to take from the various Union ports, where they were in use prior to the war, and convert them to minesweepers, guard ships, and other purposes; and also on improvement and straightening of lines. The project further includes the building of many stations, modern factories, and workshops to replace old buildings now in use. The buildings contemplated even embrace the possible building of up-to-date hotels at certain large centres, in order to improve on present facilities and so encourage the tourist traffic. The workshops referred to include large workshops at the new Cape Town dry dock, now being built. At Durban also important works have been determined upon, including the provision of new workshops at the graving dock; at East London docks new erecting and machine shops will be provided. The new workshops will be very considerably larger than those they displace. Prior to the outbreak of war the volume of repairs to war vessels and merchant ships carried out at Union ports was comparatively light, but as the war developed the number of ships calling for repairs rose steadily, and there is no doubt that when peace returns much more repair work will have to be carried out here, especially at Cape Town, than in the past, and provision is being made accordingly.

The Railway Administration, in addition to these plans, has not lost sight of probable post-war needs in other directions, and is making its plans for the future welfare of railwaymen returning from active service and for the absorption of many others who will be seeking employment. By building up in its Rates Equalisation Fund a reserve which, it is hoped, will reach £7,000,000, it is insuring against retrenchment or wage cuts in the difficult years after the war. The S.A. Railways and Harbours will thus go on long after the war is over. It will play as big a part in reconstruction as it has in its efforts to secure victory. Its after-war programme will provide employment for thousands of men for years and will open up permanent careers for many. A big new railway training centre will lay sound foundations for the careers.

It should be mentioned that in Abyssinia a South African Railways engineer is temporary general manager for the recovered territory, with the Italian ex-general manager as a subordinate.

Errata.—"International Trade After the War," page 277, October 2nd issue, for "Institute of Transport," read "Institute of Export." In the article on the "Churchill" tanks, page 283, for "Sprintern" read "Sprinter IV."

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer

Iron and Steel in the United States

The leaders of the iron and steel industry in the United States have recently drawn attention to the need for additional new capacity in the industry. One official was recently quoted as saying that of some seventeen blast-furnaces planned early in 1942, only one had been put into production. At the same time, at least 7,000,000 tons of pig iron, equivalent to an output of sixteen blast-furnaces, was required to meet the demand of the open-hearth steel furnaces and balance the scarcity of scrap. Great efforts are being made to expand the production of those blast-furnaces in operation. Record outputs are reported in several cases, and in August a production of 1440 tons daily was achieved by a furnace at the Lackawanna Works, at Buffalo, of the Bethlehem Steel Corporation. This is claimed to be a world's record. In the Youngstown district twenty-three out of twenty-five local furnaces are operating at capacity, but it is thought that several of these will shortly have to shut down. The August shipments of iron ore down the Great Lakes totalled 13,177,000 gross tons. The Ore Fleet now consists of 337 vessels, which include 35 Canadian, which have been admitted under recent legislation permitting them to engage in the United States coastal trade. The bulk of the ore thus shipped is for furnaces adjacent to the Lakes, but a large proportion is forwarded by rail to the Pittsburgh, Youngstown, and Ohio districts, and this year a large tonnage has been sent from Lake ports to the Atlantic seaboard furnaces. It is estimated that the steel production of the country averages 97·60 per cent. of steel ingot capacity, which is equivalent to 1,669,600 tons of ingots weekly. It is expected that the operations at the tinplate mills will fall to 50 per cent. of capacity in the last quarter. The electrolytic and bonderised mills are not yet in full operation. Some of the old hot mills may work on first-quarter "Lend-Lease" orders already booked, and this should keep them busy until the end of 1942. The costs in the industry are tending to increase, and this has drawn attention to the fact that prices have remained unchanged for three years. Domestic quotations are not applicable to "Lend-Lease" business, which is taking about 90 per cent. of the available tonnage.

The Pig Iron Market

The demand for pig iron is steady, but in a few departments it lacks the insistent pressure which characterised the trade a comparatively short time ago. The volume of business in foundry iron has declined over the past few weeks, largely as a result of the concentration scheme affecting foundries, which does not appear to be making rapid progress. The uncertainty felt regarding the scheme is reflected in the reluctance of consumers of ordinary grades of foundry iron to commit themselves to more than hand-to-mouth purchases. There is plenty of high-phosphoric pig iron available, and the light castings industry is rather better employed than it was. The majority of the foundries are not too well placed for orders, and there has been some restriction of the output of high-phosphoric qualities. Consumers able to use this description, however, find no difficulty in satisfying their wants. The engineering foundries, including heavy electrical engineers and machine tool makers, are taking up fairly large tonnages, although their requirements are principally for the higher quality pig irons. Makers of special refined irons find a ready sale for their products, and, of course, more hematite could be consumed than is available. The Control continues to watch the hematite position closely, and only in cases where the use of this iron is essential is it released. The production of foundry iron on the North-East Coast is limited, and attention is principally concentrated upon the production of basic pig iron for the steel works. Recently there has been an expansion in the demand for medium-phosphoric pig iron. Generally, founders have frequently to use descriptions to which they are not accustomed, but they appear to be successfully overcoming any difficulties arising from this cause. The Scottish blast-furnace industry is turning out good quantities of pig iron which pass at once into consumption, but English users of Scottish foundry would be glad to obtain larger quantities than they are receiving.

The Midlands and South Wales

Production at the iron and steel works in the Midlands is at record levels, but, even so, the steel makers are hard pressed to keep pace with the demand. Fortunately, the raw materials position is satisfactory, the more so as it is expected that the iron and steel industry will be called upon for fresh efforts to increase outputs during the last quarter of the year. The pressure of the demand for the re-rolling works has increased during the past few weeks, but, fortunately, they are receiving adequate quantities of semis. This is rather contrary to expectations, since a short time ago the re-rolling industry was given to understand that further supplies of imported semis would be greatly reduced. Actually, during the last week or two imports have shown an increase. The home production also has been at a heavy rate, and there have been larger supplies reaching the Midland re-rolling works from Welsh makers. Fair supplies of shell discard steel are now being used, as well as quantities of defective sheet bars and billets. The industry generally has enough work in hand to keep it busily employed until the fourth delivery period. Considerable business is passing in small bars and light structural material, and it seems likely that this demand will continue to keep the re-rollers busy for a long time. The general features of the steel market have not altered much during the latter part of the third quarter. The demand for plates is still a feature of the market, and large quantities are going into consumption. At the same time there is no slackening in the alloy steel requirements of the armaments and munitions makers, and, wherever possible, the production of this class of material is being increased. The recent improvement in the demand for bar iron has been maintained, but there are a number of works which would be glad to receive fresh business. Activity in this section of the market is greatest in the small sizes, but there is a fair request for best iron and Crown bars. The sheet works have a good volume of orders in hand and a considerable amount of fresh inquiry is in circulation. The orders reaching the steel works in South Wales are sufficient to keep them operating at a high rate. The pressure to obtain plates continues, and considerable quantities are going to the shipbuilders and ship repairers. If anything, the volume of business in structural steel seems to be increasing. The market for tinplates and their substitutes is quiet, but the industry is moderately busy on orders in hand, and there is rather a better demand for sheet and tinplate bars.

The North-East Coast and Yorkshire

The heavy amount of orders from the Government keeps the iron and steel works on the North-East Coast working at top pressure. Production is at a high level and big outputs of open-hearth steel have been obtained. The demand for semis is urgent and insistent and large tonnages are passing to the consuming industries. Even with the home works producing at capacity, however, the production is barely sufficient to meet consumers' needs, and withdrawals from the stocks of imported materials have to be made. These withdrawals, however, are less than was the case a few weeks ago. The armaments and munitions makers are fully occupied, and their demands for special and alloy steels appear to be growing, and, in spite of the large increase in home production of these descriptions, the demand taxes the resources of the makers. The improvement in the demand for heavy structural steel is keeping the producing works well employed, and this demand, which arises from Government contracts which have been placed with constructional engineers is likely to last for some time. Big business is also passing in plates, the chief demand coming from the shipbuilding and ship-repairing yards. The tendency noticeable recently for delivery dates to lengthen appears to have been checked in some measure, but the producing works are heavily pressed to keep pace with consumers' requirements. In the Yorkshire steel-making districts the pressure of demand is unrelaxed. A heavy tonnage of orders is in hand for special and alloy steels and most of them are of high priority. The demand for high-speed steels is urgent, and important quantities of substitute high-speed steel are being consumed. There is also an active demand for high-tungsten high-speed steel. Considerable quantities of acid carbon steel are also passing into consumption. The war demand for iron and steel appears to be steadily increasing, and fresh extensions are being made to cope with the national requirements.

Scotland and the North

The Scottish steel works are fully occupied in meeting the heavy wartime demands, and have orders on their books which will keep them busy for several months. The demand for plates absorbs the capacity of the works, and big tonnages are being taken up by the shipyards, tank makers, and locomotive builders. Engineering works also are large consumers. There is still a tendency for delivery dates for plates to length, although plans are under consideration by which it is hoped to relieve the pressure on the producing works. Constructional engineers, who are busier than they have been upon Government orders, are taking up a good tonnage of light plates. The position in the structural steel department has improved considerably of late, and there is a better demand for heavy joists and sections, whilst the volume of business in lighter descriptions of structural steel is keeping the re-rollers busy. The outlook in this industry for the near future is satisfactory. There is an active demand for steel bars, which are being taken up in considerable volume by the engineering works. The tube works in Scotland are also actively employed, and have in hand some important contracts, includfng a fair amount for special work. Lately this branch of the industry has experienced a strong demand for water tubes. Busy conditions characterise all branches of the Lancashire steel trade. Lately there has been a noticeable increase in the volume of business in steel bars. Some of the producers of the larger diameters are quoting longer delivery periods, and this is tending to spread to medium-size bars. The re-rolling works also are kept busy on meeting orders for small steel bars. Recently the call for reinforced concrete descriptions has declined somewhat. The sheet works are well situated as regards orders, and a good deal of the work in hand is for the Government. Lately the demand for painted sheets has increased. The steel works on the North-West Coast are fully engaged, and their output is almost entirely taken up on work of national importance.

Copper, Tin, Lead, and Spelter

The copper position in Great Britain does not alter much, and the distribution of the metal appears to be running smoothly. Supplies are adequate to meet the calls of the war industries, but there is no surplus to provide metal for non-essential work. This, however, has been the case for so long and such a huge proportion of the copper-consuming industries are employed on work arising from the war, that this is no longer regarded as a hardship. Once consumers have obtained their licences, they appear to be getting all the metal they require and for the deliveries they want. Naturally, as applications for licences are so carefully scrutinised by the Control, there may be some trouble in obtaining the required permission unless the work for which the metal is needed is undeniably wanted for essential purposes. Little copper is available to fulfil export orders, although occasionally some copper seems to be released for export when it is needed for purposes which meet with the approval of the authorities. Under the operation of the C.R.M.B. (Combined Raw Materials Board), which operates from Washington, metals from the United States are allocated to the Allies, and this system appears to be working satisfactorily. The American production has been pushed to the utmost, and is probably somewhat on the up grade. Supplies of copper for non-essential purposes are drastically cut down in the United States. Consumption, however, in Great Britain and the United States is on a heavy scale, and the brass industries in particular are consuming large quantities of the metal. . . . Interest in the tin market has centred upon the new International Tin Agreement, which was signed on September 9th and is to date from January 1st, 1942. It is thought that the agreement is not likely to have much influence upon the tin position, except in maintaining the existence of the International Tin Committee, which will perform the functions of a central bureau. It was recently stated that the production of tin in China has been raised to approximately 17,000 tons. The average output for the years 1936–38 was 11,000 tons annually. The tin can salvage campaign in New York does not appear to have been very successful. Over 7000 tons of old tin cans were salvaged, of which about 25 per cent. were washed and prepared in accordance with directions; but not more than 70 tons of metallic tin have been reclaimed from this tonnage. . . . The consumption of lead in Great Britain is maintained at a high rate, and no licences are issued for unessential purposes. The Control is watching carefully over the consumption of scrap lead. The position is also somewhat tight in the United States, and the uses of the metal are restricted to essential purposes. . . . The spelter market in Great Britain and the United States remains tight. The world situation is that whilst the Germans, as a result of their conquests, have surplus refining plant, on the other hand, the Allies have a larger mining output at their disposal, but insufficient refining plant. In the United States, however, the refining capacity has been considerably increased, and the position should become easier.

Notes and Memoranda

Rail and Road

Pistons of Aluminium.—The Chicago, Burlington and Quincy Railroad of America is fitting pistons of aluminium alloy in some of its locomotives. Two nickel-bronze rings are fitted, and each ring is formed of two half rings in eight pieces maintained against the cylinder wall by a circular spring. It is claimed that these rings can run 95,000 to 100,000 miles before replacement is necessary.

Highways in Canada.—The construction of new highways and the maintenance of existing roads in Canada has assumed such volume that the Government has issued an order under which all road machinery, construction equipment, ploughs, scrapers, crawler tractors, bulldozers, dredgers, derricks, even street sweepers, and so on, to the number of sixty-seven items, must be registered by their owners with the Administrator of Farm and Road Machinery and Municipal Services. The effect of this Order is to make a complete inventory of every item of road and farm machinery in the Dominion.

Permanent International Association of Road Congresses.—Since the occupation of Paris by the Germans in 1940 no communications have been received in this country from the headquarters of the International Association of Road Congresses. The British Organising Committee considered the position in 1941 and decided that an endeavour should be made to issue a British *Bulletin* in place of the *Bulletin* which used to be issued from the headquarters of the Association. It has, however, not been possible, in view of the war, to go on with this proposal, but the British Organising Committee is being maintained and will be called together again when a useful purpose can be served by doing so.

A Cape Town Tunnel.—For some time past a project has been under consideration to cut a tunnel through Signal Hill, Cape Town. Recently a group of Cape Town business men decided to form a syndicate, provided the City Council would allow such a company to be formed. It is estimated that £325,000 would have to be raised before starting the work. The cost of building the tunnel is put at £47 per lineal foot, which would amount to about £300,000. Stone from the excavations could be sold for from £70,000 to £90,000 for use in building the new giant graving dock and reclamation. The tunnel should be constructed in twelve to eighteen months, and when completed is expected to pay on a toll basis.

Carriageway Designs for Roads.—The fifth of the series of Wartime Road Notes—"Carriageway Designs for Roads Other than Public Highways," published by H.M. Stationery Office, price 6d. net—has been issued by the Road Research Laboratory of the Department of Scientific and Industrial Research, in co-operation with the Ministry of War Transport. The note is intended to apply only to private roads serving hostels, hospitals, farms, factories, and industrial undertakings, to which the application of "public highway" standards of strength would often be unnecessarily costly. It is concerned with the structural features of carriageways and not with lay-out and location. The functions of the three component parts of a carriageway—sub-base, base, and surfacing—are outlined. The note concludes with a number of typical specifications for these parts, and references are given to easily accessible specifications published elsewhere.

Air and Water

Irrigation in the United Provinces.—Water storage and irrigation schemes for India are not to be held up by reason of the war. In the United Provinces projects which are under consideration include the construction of a new reservoir on the Dhasan River to increase the storage for the Dhasan canal, the construction of a new reservoir on the Shahzad *nadi* to supplement the storage for the Betwa canal, lost by the silting of the Dhukwan reservoir, the construction of the Ahraura canal, Mirzapur Canals Sub-division, and the construction of the Ninedeh reservoir, Mirzapur Canals Sub-division. The total length of channels in operation at the close of 1941 was 22,562 miles, as compared with 22,441 miles in the preceding year.

Society of British Aircraft Constructors, Ltd.—The Society of British Aircraft Constructors announces that Phillips and Powis Aircraft, Ltd., makers of "Miles" trainer and target towing aeroplanes for the Royal Air Force have been elected to ordinary (or full) membership of the Society. They had been associate constructor members since January, 1936. This new accession brings the number of ordinary member firms to nineteen, comprising the leading British companies engaged in the design and manufacture of aeroplanes and aero-engines. The Society is the officially recognised representative body of the British aircraft industry. Founded in 1916 at the request of the Government to represent the views of the industry as a whole on all matters of general interest, it is largely engaged in the technical development of aircraft, engines, and components and in many activities directed to improve aeroplane production, including standardisation of parts and materials, and the development of plastic substances to replace light alloys in aircraft structure.

Miscellanea

Metallurgical Research in U.S.A.—Wartime research in metallurgy, now being carried out in the U.S.A., is supervised by the Metals and Minerals Advisory Committee of the National Academy of Sciences, through a War Metallurgical Committee. Its function is to collect data and information, as requested by either the War Production Board or the Office of Scientific Research and Development, and to plan, present, and supervise definite research projects.

Canadian Machine Tool Makers Form an Association.—Prompted by the urgency of retaining skilled mechanics and keymen in the machine tool and cutting tool and gauge industries, an association, known as Canadian Machine Tool Builders' Association, has been formed. Mr. H. G. Bertram, representing John Bertram and Sons, Ltd., Dundas, Ont., is the first President. Mr. E. Barker, of Toronto, is the Secretary. Canadian Government Departments were represented at the meeting when the Association was formed by the Machine Tools Controller, the Director-General of Gauges and Cutting Tools, and others.

The Lord Hirst Fund.—It was announced at the meeting of the Institution of Electrical Engineers, held on October 1st, that the Council had accepted with pleasure and gratification a gift by Lord Hirst of Witton, Hon. Member of the Institution, of £20,000 for the use of the Benevolent Fund of the Institution. The members were informed that under the trust deed executed by Lord Hirst, Mr. J. S. Highfield, and Dr. Clifford C. Paterson (Past-Presidents of the Institution), and Sir Noel Ashbridge (the retiring President) had been appointed trustees of the Fund, which would be known as the "Lord Hirst Fund," and would be administered by them with the help of the Committee of Management of the Benevolent Fund, who would make recommendations for the purpose of giving assistance to those applicants for help (or to their dependents) who had rendered important services to electrical science or electrical industry of electrical engineering.

Personal and Business

Mr. W. Core, manager of the London office of Alfred Herbert, Ltd., has been appointed a departmental director.

Mr. R. F. Mair has been appointed secretary of the Edison Swan Electric Company, Ltd., and of Edison Swan Cables, Ltd.

Mr. M. W. H. Lancaster has been elected chairman of Allen West and Co., Ltd., in succession to the late Mr. D. W. R. Green.

The Crown Agents for the Colonies have appointed Mr. G. F. Cooke to be assistant engineer, Sierra Leone Government Railways.

Mr. J. Bainbridge and Mr. R. C. Pedder have been appointed additional managing directors of Charles Howson and Co., Ltd., Liverpool.

The Board of Trade announces the appointment of Lord Forres as Director of Office Machinery, in succession to the Hon. Geoffrey Cunliffe, who has joined the Ministry of Production, but still remains a member of the Industrial and Export Council.

Dr. L. R. Underwood, D.Sc. (Eng.), Ph.D., has resigned his position of chief engineering officer to the rolling mill technical department of the British Iron and Steel Federation to join the technical staff of W. H. A. Robertson and Co., Ltd., Lynton Works, Bedford.

Mr. W. S. Blaikie, A.M.I. Mech. E., manager of the Yorkshire depôt of Ferodo, Ltd., retired on September 30th, after thirty years' service, and is succeeded by Mr. E. J. Power, previously manager of the company's Liverpool depôt. Mr. E. Taylor, Dublin manager, has been appointed to the Liverpool branch.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Austrian Engineers, Chemists, and Scientific Workers in Great Britain

Thursday, Oct. 15th.—Austria House, Eaton Place, S.W.1. "Modern Industrial Organisation," Professor G. Schlesinger. 7.30 p.m.

British Standards Institution

Thursday, Oct. 22nd.—Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1. Annual general meeting. 12.15 p.m.

Illuminating Engineering Society

Tuesday, Oct. 13th.—E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, W.C.2. Presidential Address, R. O. Ackerley. 5 p.m.

Institute of Economic Engineering

Sunday, Oct. 11th.—Waldorf Hotel, Aldwych, W.C.2. "Synthetic Data in the Machine Shop," R. N. D. Roon. 2.30 p.m.

Institute of Fuel

Tuesday, Oct. 13th.—Inst. of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. Presidential Address, W. M. Selvey. 2.30 p.m.

Institute of Physics

Monday, Oct. 12th.—Royal Institution, 21, Albemarle Street, W.1. Discussions, "The Education of a Physicist," 10.30 a.m.; "Training for Research in Industrial and Applied Physics," 2 p.m.

Institution of Automobile Engineers

Sunday, Oct. 11th.—London Graduates: 12, Hobart Place, S.W.1. "A Post-war Motor Vehicle," L. H. Hounsfield. 3 p.m.

Tuesday, Oct. 13th.—Luton Graduates: Technical College, Luton. "The Trend of Industrial Organisation," R. Pearson. 7.30 p.m.

Institution of Chemical Engineers

Tuesday, Oct. 13th.—Geological Society's Rooms, Burlington House, Piccadilly, W.1. "The Production of Radium," E. F. MacTaggart. 2.30 p.m.

Institution of Electrical Engineers

Tuesday, Oct. 13th.—Scottish Centre: Royal Technical College, George Street, Glasgow, C.1. Chairman's Address, W. Sutcliffe. 6.15 p.m.

Wednesday, Oct. 14th.—Transmission Section: Savoy Place, Victoria Embankment, W.C.2. Chairman's Address, P. E. Rycroft. 5.30 p.m.—Scottish Centre: Heriot-Watt College, Edinburgh. Chairman's Address, W. Sutcliffe. 6.30 p.m.

Thursday, Oct. 15th.—Installations Section: Savoy Place, Victoria Embankment, W.C.2. Chairman's Address, R. Grierson. 5.30 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tuesday, Oct. 20th.—39, Elmbank Crescent, Glasgow. Presidential Address, F. C. Stewart. 6.30 p.m.

Institution of Mechanical Engineers

To-day, Oct. 9th.—Storey's Gate, Westminster, S.W.1. "The Training Activities of the Ministry of Labour," E. Watson Smyth. (Informal meeting.) 5.30 p.m.—Scottish Graduates' Section: Royal Technical College, Glasgow. "Wartime Effects on Engineer and Patent Law," R. W. Cunningham. 7.30 p.m.

Thursday, Oct. 15th.—Midland Branch: James Watt Memorial Institute, Birmingham. "Fencing of Machinery," H. A. Hepburn. 5.30 p.m.

Institution of Production Engineers

Saturday, Oct. 10th.—Yorkshire Section: The University, Leeds. "High Speed in the Production Shop," Dr. G. Schlesinger. 2.30 p.m.

Saturday, Oct. 17th.—Manchester Section: Houldsworth Hall, Manchester. "Some Post-war Industrial Problems," Dr. A. P. M. Fleming. 2.30 p.m.

Iron and Steel Institute

Saturday, Oct. 10th.—198, West Street, Sheffield. "The Rationalisation of Specifications to Meet Wartime Needs," Dr. W. H. Hatfield. 2.30 p.m.

Junior Institution of Engineers

To-day, Oct. 9th.—39, Victoria Street, S.W.1. "Sinking and Erection of Cast Iron Tubbings," H. A. Hatt. 6 p.m.

Manchester Association of Engineers

Saturday, Oct. 10th.—Engineers' Club, Albert Square, Manchester. "Plastics and their Application to Engineering," J. Prior. 2.30 p.m.

Manchester Geological and Mining Society

Tuesday, Oct. 13th.—Queen's Chambers, John Dalton Street, Manchester. Annual general meeting. 2.45 p.m.

Newcomen Society

Wednesday, Oct. 14th.—Iron and Steel Institute, 4, Grosvenor Gardens, S.W.1. "John Edwards (1731–1807), Cornish Industrialist," T. R. Harris; "Early Engineering and Ironfounding in Cornwall," Rhys Jenkins. 2.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders

Friday, Oct. 16th.—Literary and Philosophical Society, Newcastle-upon-Tyne. Annual general meeting. Presidential Address, J. R. Gebbie. 6 p.m.